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ERRATA

There was an error in Table A, page 1.0, of Report No. 139. Production in Canada during 1979 should have been 17.5 million pounds U_3O_8, not 15.0 million pounds. The corrected table is shown below.

Table A

ESTIMATED WORLD URANIUM PRODUCTION
(millions of pounds U_3O_8)

	1978	1979
United States	37.0	37.0
Canada	17.5	17.5
Republic of South Africa	10.3	12.5
Other Africa	15.0	22.0
Other nations*	7.2	9.5
TOTAL	87.0	98.5

*Does not include Communist areas.

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NUEXCO

MONTHLY REPORT
ON THE URANIUM MARKET

NO. 140

APRIL 1980

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT NO. 140

The **Exchange Value** decreased again this month from $38.00 to $35.00 per pound U_3O_8. There has been a general absence of utility buyers from the market, due primarily to the existence of large inventories. US and worldwide inventories average about two-and-one-half to three years forward consumption High interest rates in the US have made uranium inventories expensive to hold. Thus no US utilities are known to be intentionally adding to inventories, and some are attempting to reduce inventories by offering material for sale on the near-term market. The only potential buyers currently in the market are producers, which might buy on the near-term market to deliver under existing contracts, rather than produce the material themselves. The economic limitations involved in such make-or-buy decisions have put additional downward pressure on an already declining market.

Nuexco has recomputed its estimates of **Apparent Future Consumption**. Estimated worldwide cumulative consumption from 1979 through 1990 is down by approximately ten percent from Nuexco's last published estimate (Report 132, July 31, 1979). Estimated cumulative consumption for the **US** during the same period also declined by about ten percent. Licensing delays and plant cancellations are primarily responsible for the decrease in the US. Estimated consumption for **Japan** declined considerably, due mainly to changes in Nuexco's computational groundrules regarding planned capacity additions and capacity factors for Japan. *Consumption* is defined by Nuexco as having occurred when natural uranium enters the nuclear fuel enrichment-fabrication pipeline, for ultimate use in a reactor.

In **Sweden**, more than 58 percent of the voters in the March 23 nuclear referendum endorsed the continued use of nuclear power. Two new nuclear units will start up in Sweden this year, in addition to the six already operating.

In **Australia**, Queensland Mines has completed construction of its Nabarlek production center. Metallurgical testing is now underway, and production is expected to begin later this year. Photographs of the Nabarlek site are included in this Report.

This month's *Topical Essay* is the sixth in a series on various aspects of uranium marketing and procurement. It focuses on delivery and payment provisions in uranium supply contracts.

The *Raw Materials* section begins a two-part series on uranium occurrence in quartz-pebble conglomerates.

This Executive Summary may be reproduced for internal distribution.

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NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

No. 140 April 1980

MANAGING EDITOR:
JAMES E. VAUGHAN

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MICHELE-DANIELE V. PATIN

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FOREWORD

We are delighted to announce that Mr. W. Hardy Prentice has joined Nuexco as a Representative, serving the north-central United States. Hardy was with the General Electric Company for more than forty years, until his retirement in 1977. Most recently he was a Regional Manager in the Electric Utility Sales Division. He is a graduate of Kansas State University and is a Registered Professional Engineer. Hardy now lives in Cleveland, Ohio.

Enclosed with this Report is a copy of a talk by George White, Jr. delivered on March 5, 1980 at the Dain Bosworth Institutional Investors Conference at Vail, Colorado.

PUBLIC AND GOVERNMENT POLICY

More than 58 percent of the vote in the **Swedish referendum** of March 23 was pro-nuclear. About 38.5 percent was against nuclear power. The remaining votes cast were blank. Although the vote is not officially binding, the government previously stated it will consider it binding. Thus the six units presently operating will continue to operate. Also, the government has approved the resumption of startup activities at the 900 MW Ringhals unit 3, a PWR, and the 900 MW Forsmark unit 1, a BWR. These units are expected to be in service this year. The government is also expected to allow work to continue on Ringhals unit 4 and Forsmark unit 2. Work is also expected to begin soon on the final two nuclear units referenced in the referendum.

In the **UK**, the Protection of Trade Interests Bill has been approved by the House of Lords, and is now law. Under this legislation—designed in part to counteract the US antitrust actions in the uranium industry—the punitive portion of multiple judgment awards (e.g. two-thirds of a treble damage award in a civil suit brought under US antitrust law) will not be recoverable in Britain. It also permits British companies to recover in British courts any multiple damages paid under a judgment in a US or other foreign court. A bill similar to the British legislation has been introduced into committee in the House of Commons of **Australia**.

The most recent estimates indicate that **Belgium** will be bringing one new nuclear unit on line in each of the four years 1981 through 1984. (Doel 3 and 4 in 81 and 83, Tihange 2 and 3 in 82 and 84). If this schedule is achieved, it is expected that about 50 percent of Belgium's electric production will be supplied by nuclear power by the end of 1984.

GENERAL

Estimates of Apparent Future Consumption

In Report 132, dated July 31, 1979, Nuexco presented revised estimates of Apparent Future Consumption of U_3O_8. Subsequent events warrant revising those estimates once again. Table 1 presents Nuexco's estimates of Apparent Future Consumption as of March 31, 1980. (The term *consumption* as used by Nuexco refers to U_3O_8 entering the enrichment-fabrication pipeline.) The corresponding installed nuclear generating capacities are shown in Table 2.

US. The US has undergone some dramatic changes in the past eight months. Reaction to the accident at Three Mile Island, regulatory problems, double-digit inflation, soaring interest rates, and reduced projections of utility load growth have contributed to numerous cancellations, deferrals or delays of nuclear power plants. Although Nuexco's current estimates represent a cumulative reduction (since the last Nuexco estimate, July 31, 1979) of more than 50,000,000 pounds U_3O_8 in US consumption through 1990, further reductions can still be expected.

The maximum anticipated level of US consumption during the 1980's is also lower than previous estimates. Table 1 indicates a maximum US consumption level of about 50,000,000 pounds U_3O_8 per year, and this level is not reached until 1988. The 1979 US consumption level of 24,800,000 pounds U_3O_8 is a revised figure based on 1979 operating experience. This is a reduction of 3,800,000 pounds U_3O_8 from Nuexco's July 31, 1979 estimate. The current consumption estimate for 1980 is 3,100,000 pounds U_3O_8 lower than the previous estimate. These reductions serve to further exacerbate the current uranium market imbalance, discussed in more detail in the Pricing Section of this Report.

Table 1 indicates a large jump in annual US Apparent Future Consumption after 1980. This is based on the anticipated startup in 1983 of twelve reactors now under construction. That number of new licenses will very likely overload the US NRC's capacity for licensing review. Furthermore, the estimate includes startup during 1980 of almost all of the 14 reactors which were nearly ready to begin operation as of the end of the US NRC licensing moratorium which ended in February, 1980. It is highly unlikely that all of those reactors can begin commercial operation on schedule. Under current conditions in the NRC, it is likely that no more than six to eight US reactors can be licensed in a given year. Therefore about half of the anticipated 1980 startups will very likely be delayed to 1981. Likewise, many anticipated 1981 startups will be delayed to 1982, 1982 startups to 1983 or 1984, and so on. Under this scenario, additional startup delays of forty reactor-years or more are likely. Such a situation would further reduce cumulative Apparent Future Consumption (i.e. fundamental US demand)

Table 1: APPARENT FUTURE CONSUMPTION[a]
(Annual, Millions of Pounds U_3O_8 equivalent)

BUYER GROUP	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
United States:												
Reactors Now Operational	16.3	17.6	17.7	17.4	17.9	18.2	18.4	17.8	18.3	18.4	18.3	17.8
Now under Construction	8.5	10.9	19.7	22.5	24.6	23.6	23.1	25.3	25.5	25.5	25.2	25.2
Now on Order	0	0	0	0	2.0	2.4	4.8	4.4	4.3	5.6	7.8	7.3
US Subtotal	24.8	28.5	37.4	39.9	44.4	44.2	46.4	47.5	48.1	49.6	51.3	50.3
Europe:												
Reactors Now Operational	12.8	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
Now Under Construction	22.0	15.2	23.1	22.6	21.7	22.0	21.6	20.7	21.0	21.0	21.0	21.0
Now on Order	0	0	0	0.9	5.1	6.4	8.3	6.1	6.3	6.7	6.7	6.7
Europe Subtotal	34.8	29.6	37.5	37.9	41.2	42.8	44.3	41.2	41.7	42.1	42.1	42.1
Far East[b]:												
Reactors Now Operational	4.6	4.6	4.6	4.6	4.6	4.7	4.7	4.7	4.7	4.7	4.7	4.7
Now under Construction	1.5	3.1	3.0	5.6	4.1	4.6	5.4	4.8	4.8	4.8	4.8	4.8
Now on Order	0	0	0.7	1.8	3.5	2.2	2.9	2.9	2.3	2.7	2.7	2.7
Far East Subtotal	6.1	7.8	8.3	12.1	12.2	11.5	13.1	12.4	11.8	12.3	12.3	12.3
Other Free World[c]:												
Reactors Now Operational	2.3	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Now under Construction	0.7	1.5	2.7	4.3	3.5	5.0	4.1	4.4	4.4	4.4	4.4	4.4
Now on Order	0	0	0	0	0	1.5	1.9	1.2	1.9	1.9	1.8	2.1
Other Subtotal	3.0	3.7	4.9	6.5	5.7	8.7	8.2	7.9	8.5	8.5	8.5	8.8
FREE WORLD[c] TOTAL[d]	68.7	69.6	88.1	96.4	103.5	107.2	112.0	109.0	110.1	112.5	114.2	113.5
WORLDWIDE BREAKDOWN BY STATUS:												
Reactors Now Operational	36.0	38.8	38.9	38.6	39.1	39.5	39.7	39.1	39.6	39.7	39.6	39.1
Now under Construction	32.7	30.7	48.5	55.0	53.9	55.2	54.2	55.2	55.7	55.7	55.4	55.4
Now on Order	0	0	0.7	2.7	10.6	12.5	17.9	14.6	14.8	16.9	19.0	18.8

NOTES:

a. Computed quantites of U_3O_8 which would be used under the given conditions, to fabricate fuel for loading and reloading reactors operating, under construction or on order. Compiled and computed on a reactor-by-reactor basis, quantities for each reactor are based on specific core characteristics, 0.20% tails assay, no recycling, 24-month lead time for procuring first cores and 18-month lead time for procuring each reload. Assumes reloads occur one year after commercial operating date and annually thereafter. 1979 figures reflect actual capacity factor achieved by each reactor. Estimates for 1980-1990 use Nuexco estimates of individual reactor capacity factor.

b. Japan, Korea, Philippines, Taiwan.

c. Excludes Bulgaria, Czechoslovakia, German Democratic Republic, Finland (2 Russian reactors), Hungary, Poland, Romania, USSR.

d. Differences up to 0.2 millions lbs U_3O_8 are due to round-off error.

Table 2: INSTALLED NUCLEAR CAPACITY x 1000 MWe (net)[a]

BUYER GROUP	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
United States:												
Reactors Now Operational	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Now under Construction	0	10.9	18.0	24.5	36.0	48.5	59.7	66.3	72.4	74.8	77.1	78.4
Now on Order	0	0	0	0	0	0	2.3	4.7	8.2	11.5	12.6	15.6
US Subtotal	50.0	60.9	68.0	74.4	86.0	98.5	111.9	121.0	130.7	136.3	139.7	143.9
Europe:												
Reactors Now Operational	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3
Now under Construction	0	8.5	27.0	36.2	48.0	55.9	58.5	60.5	61.5	61.5	61.5	61.5
Now on Order	0	0	0	0	0	0.9	6.9	13.1	18.9	20.0	21.3	21.3
Europe Subtotal	36.3	44.9	63.3	72.5	84.3	93.1	101.7	109.9	116.7	117.9	119.1	119.1
Far East[b]:												
Reactors Now Operational	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
Now under Construction	0	0	1.5	4.7	6.3	10.6	12.4	13.3	14.3	14.3	14.3	14.3
Now on Order	0	0	0	0	0.8	2.7	5.7	6.8	7.8	8.7	8.7	8.7
Far East Subtotal	16.3	16.3	17.8	20.9	23.5	29.6	34.4	36.4	38.3	39.3	39.3	39.3
Other Free World[c]:												
Reactors Now Operational	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Now under Construction	0	1.0	2.3	3.7	6.1	9.7	10.3	12.3	13.1	13.1	13.1	13.1
Now on Order	0	0	0	0	0	0	0	0.6	3.3	4.3	5.1	6.0
Other Subtotal	6.5	7.6	8.8	10.2	12.6	16.2	16.8	19.4	22.9	23.8	24.7	25.6
FREE WORLD[c] TOTAL[d]	109.1	129.7	157.9	178.0	206.4	237.4	264.8	286.7	308.6	317.3	322.8	327.9
WORLDWIDE BREAKDOWN BY STATUS:												
Reactors Now Operational	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1
Now under Construction	0	20.4	48.8	68.9	96.5	124.7	140.8	152.4	161.3	163.7	166.0	167.2
Now on Order	0	0	0	0	0.8	3.6	14.9	25.2	38.2	44.5	47.7	51.6

NOTES:

a. Uses Nuexco estimates of commercial operating dates.

b. Japan, Korea, Philippines, Taiwan.

c. Excludes Bulgaria, Czechoslovakia, German Democratic Republic, Finland (2 Russian reactors), Hungary, Pland, Romania, USSR.

d. Differences up to 200 MWe are due to round-off error.

by fifteen million pounds U_3O_8 or more through 1990.

The total of 50,000 MWe (net) in Table 2 under the classification of *Reactors Now Operational* in the US is based on 69 reactors. Shippingport and Hanford were not included. Arkansas Nuclear unit 2 was not included in the *Reactors Now Operational* category because it has not yet been declared commercial. Sequoyah unit 1 was not included because its license is for startup testing only. Requirements for both these reactors were included under the category of *Reactors Now Under Construction*. Included in the 69 reactors were Indian Point unit 1, Humboldt Bay, and TMI unit 2, even though these plants are indefinitely shut down. Requirements estimates in Table 1 for the latter three units would reflect their non-operational status.

Europe. Nuexco's current estimate of Apparent Future Consumption for Europe represents a cumulative reduction of approximately 15,000,000 pounds U_3O_8 in fundamental demand since the last published Nuexco estimate. Some or all of this reduction could well be offset by new reactor orders in the aggressive French nuclear program.

Far East. This market has been relatively quiet in recent months. However, Nuexco's current estimates of Apparent Future Consumption are considerably lower than those published July 31, 1979. These differences are due to two major revisions in Nuexco's procedures for estimating consumption in Japan:

- —Substantially reduced estimates of capacity factor;
- —Narrower interpretation of the term "on order".

Japan's nuclear regulatory structure is such that it has been difficult for Japanese reactors to average much more than 75 percent availability. As a result, Japan's national average capacity factor was only about 50 percent in 1979. While this situation may change with time, Japanese operating and regulatory practice appears to have been so consistently conservative that Nuexco believes it will continue in that direction. Therefore the current estimate of Apparent Future Consumption for Japan is based on recent operating experience for reactors now operational. For Japanese reactors under construction or on order, a nominal capacity factor of 50 percent was used in this estimate. In prior estimates Nuexco used capacity factors based on expectations of average performance. This change of course results in considerably lower consumption levels.

The second change in Nuexco's procedures for estimating Japanese uranium consumption concerns the treatment of the category of "plants on order." Japan is unusual in that there are no reactors currently on order scheduled for startup later than 1986, although present plans call for substantial additions to nuclear generating capacity after that year. Sites have been selected for other plants, but formal orders have not yet been placed. In prior estimates, Nuexco included such planned reactors in its consumption forecasts for Japan, even though planned—but not ordered—reactors were not included elsewhere in the world. The current estimate reverses this position, and only reactors now operational, under construction, or on order are included. Thus the estimate of fundamental Japanese demand in this Report is considerably lower than previous Nuexco estimates.

Methodology. In order to facilitate interpretation of the results presented, the methodology used in developing the concept of Apparent Future Consumption, first published in Nuexco Report 128, is repeated here in condensed form:

1. Estimates of Apparent Future Consumption are not forecasts of uranium demand. Rather, these estimates comprise a portion of uranium demand. As indicators of the amount of uranium needed to fuel the reactors under consideration, these estimates should be regarded as relatively hard demand in the sense that this portion of demand is quite insensitive to uranium prices. Market demand *for the assumed pattern of capacity additions* can be higher, but not likely lower.
2. Components which can cause demand to exceed Apparent Future Consumption are:
   a. Utility buyers plan their procurement strategies to achieve a very high probability of having access to at least enough uranium to meet commitments as they arise;
   b. Accelerated reactor construction schedules can advance the dates of uranium need;
   c. Buyers may elect to purchase uranium in excess of need, simply to enhance security of supply.

3. Apparent Future Consumption is based on information available today subject to frequent revision as the date of consumption draws nearer.
4. Uranium is deemed to have been consumed when it has entered the enrichment-fabrication pipeline for ultimate use in a reactor.
5. Reactor loading was calculated, for each reactor, based on its individual core characteristics. This technique is distinct from the method customarily used in estimating reactor requirements simply as a direct function of installed capacity.
6. The estimates assume that: a. U_3O_8 deliveries for first cores predate commercial operation by two years. b. First reload occurs 12 months after commercial operating date and annually thereafter. c. U_3O_8 delivery for each reload predates reload by 18 months.
7. Using the assumptions listed above, the estmate for a given reactor can be computed as a function of assumed capacity factor, tails assay and commercial operating date.
8. Reactors fueled by the USSR are excluded. Although Soviet bloc reactors account for substantial demand, Soviet participation in uranium trading has been negligible and appears likely to remain so.
9. Actual commercial operating dates can vary widely from published dates. Nuexco uses the best information available, much of it from unpublished sources, to prepare its own estimates of operating dates.
10. These estimates make no provision for orders not yet placed. Only the requirements associated with reactors operating, under construction or on order are included. Consequently, none of these estimates can be compared directly to forecasts of uranium requirements. Rather, these estimates should be regarded as minimum requirements.
11. The analysis period of 12 years was chosen as an arbitrary measure of the longest expected time interval between inception and commercial operation of a nuclear power plant.

Statistical Data

Beginning in this issue, Nuexco will reprint the "Average Declared Working Costs per Metric Ton of Gold Ore Milled" published by the Chamber of Mines of South Africa. It is commonly called the "Chamber of Mines Index." The following discussion defines the term "working costs" and presents a breakdown for a typical gold mine. Capital expenditures are included in working costs only to the extent that they are charged against current expenses rather than capitalized. Taxes and government royalties are not included.

Typical working cost categories used by South African gold mining companies which are members of the Chamber of Mines are as follows:

(1) White labor charges
(2) Non-White labor charges
(3) Occupational diseases levy
(4) Stores and materials
(5) Electric light and power, compressed air and water charges
(6) Outside contractors
(7) Payments to S.A. Government
(8) Payments to provincial and local authorities
(9) Administration
(10) Other

Table 3 contains some examples of working costs since 1939.

Table 3
Chamber of Mines Index
(Rands/ton milled)

Year	1939	1948	1957	1963	1975
White labor	0.65	0.94	1.64	1.86	4.04
Non-white labor	0.44	0.52	0.80	0.91	4.51
Stores and materials	0.79	1.06	1.85	2.20	5.59
All other costs	0.26	0.34	0.72	0.89	2.62
Total cost per ton	2.14	2.86	5.01	5.86	16.76

As stated in previous Nuexco Reports, the major reason for Nuexco's reprinting statistical data such as the Chamber of Mines Index is to assist Subscribers in assessing changes in uranium production costs, and the effect of such changes on industry viability. Since virtually all of South Africa's uranium is produced in association with gold mining, inferences concerning uranium drawn on the basis of the Chamber of Mines Index should be carefully scrutinized. Most mines still consider uranium a by-product, and the cost of mining and milling the ore is related to gold production. Uranium production is considered separately. In some mines, however, both uranium and gold are required for viability, so mining and milling costs are treated differently from the "by-product" mines. In any event, the gold market should be a primary consideration in any assessment of the South African uranium industry.

Beginning with this Report, Nuexco will also reprint the South African Consumer Price Index. Statistical data for the Republic of South Africa appear on page 4.8 of this Report. Page 4.9 contains detailed historical data for the years 1970 through 1979.

Africa

The outcome of the recent elections in Rhodesia, with the overwhelming success of the Marxist faction, could have a marked effect on stability in southern Africa, and settlement prospects in **Namibia.** The process is once more under way toward a negotiated, internationally accepted settlement in Namibia. Prior to the Rhodesian elections, it was felt that the future independent government of Namibia would favor free-enterprise, given the success of the Democratic Turnhalle Alliance in the previous internal elections there. However the turnabout in Rhodesia in the internationally-accepted independence elections held in March have led to speculation that the same pattern might be followed in Namibia.

The world's largest uranium production facility, Rossing, is located in Namibia. It is currently running at its design rating of about 10,000,000 pounds U_3O_8 annually. Although Rossing's reserves are probably sufficient to warrant expanding its output, the chances of its doing so are very slight, given the political uncertainty in Namibia, combined with the current depressed state of the uranium market. It is also expected that Langer Heinrich will not proceed with production until the political future becomes clearer.

Australia

The negotiation of the structure and details of Energy Resources of Australia (ERA), the company which will own the Ranger deposit, are proving more difficult and time-consuming than originally expected. This is particularly true with respect to the would-be foreign equity holders which are seeking price concessions in consideration of their putting up equity capital. The Australian government has indicated, however, that it will not approve such concessions.

In addition, there is now some speculation that the **UK** will not participate in ERA, and it has been suggested that they are attempting to structure a package involving participation in Roxby Downs and a centrifuge enrichment project in South Australia. **Korea** has been mentioned as a potential new candidate for an equity position. ERA's public share offering must await the final determination of the ownership position of the foreign users.

Construction of the mill at Queensland Mines' Nabarlek deposit is complete and mechanical testing is now underway. This will be followed by water testing and then "commissioning runs" utilizing low grade material (ore containing less than 0.1 percent U_3O_8). Full production is expected by the end of June, 1980. Initial commercial deliveries are scheduled for the third quarter of 1980.

Aerial photographs of the completed Nabarlek plant are shown in Figure 1 and Figure 2. All mining has also been completed, and the ore has been stockpiled adjacent to the mill. The ore contains an estimated 26,500,000 pounds U_3O_8 at an average ore grade of 2.35 percent U_3O_8. The ore stockpile has been spray-coated with a thin layer of concrete to protect it from the weather. The mine pit is shown in Figure 3. It is planned that all mill tailings will be returned to the pit for final disposition. Figure 4 is a close-up view of the mill. All components of the mill are relatively small due to the high grade of the ore.

Far East

A number of US uranium producers report receiving inquiries from sources in **Japan** concerning the availability of material for near-term purchase and delivery. However, it is most unlikely that Japanese buyers are serious about procurement of additional material in the near term. Given the extremely long position among the Japanese utilities, it seems more likely that these inquiries are designed to provide a better fix on current market conditions and price trends in a period of fairly rapid change. It is probable that such information is being sought to buttress the Japanese position as they negotiate and/or attempt to renegotiate prices with their suppliers under long term contracts. While anxious not to disturb relation-

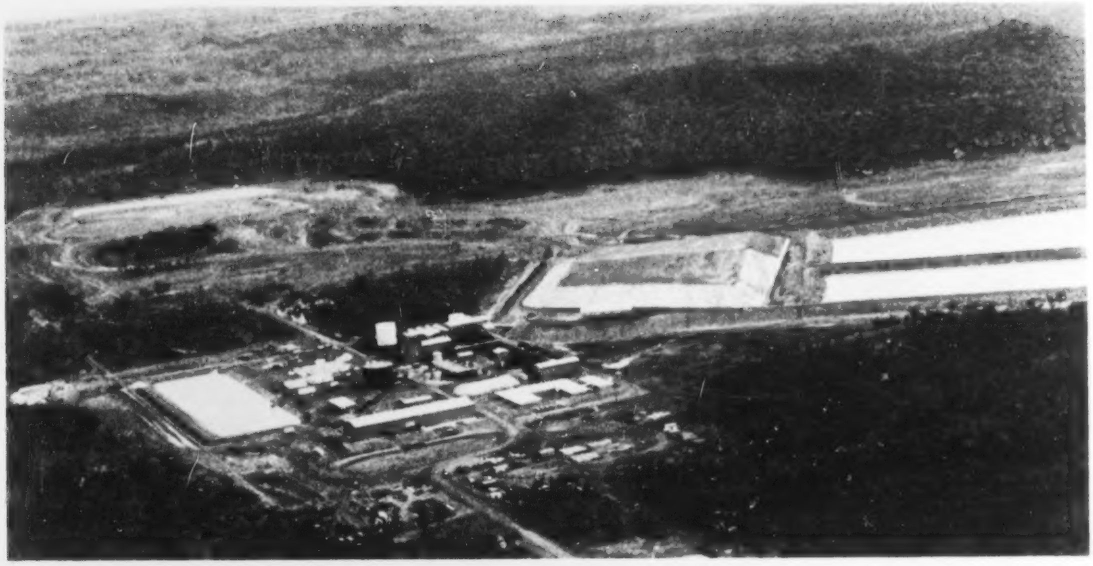

Figure 1. Aerial view of the Queensland Mines Nabarlek project. The mill is in the foreground. The ore stockpile is in the center (covered with a thin layer of concrete to protect it from the weather). The tailings evaporation pond is on the right.

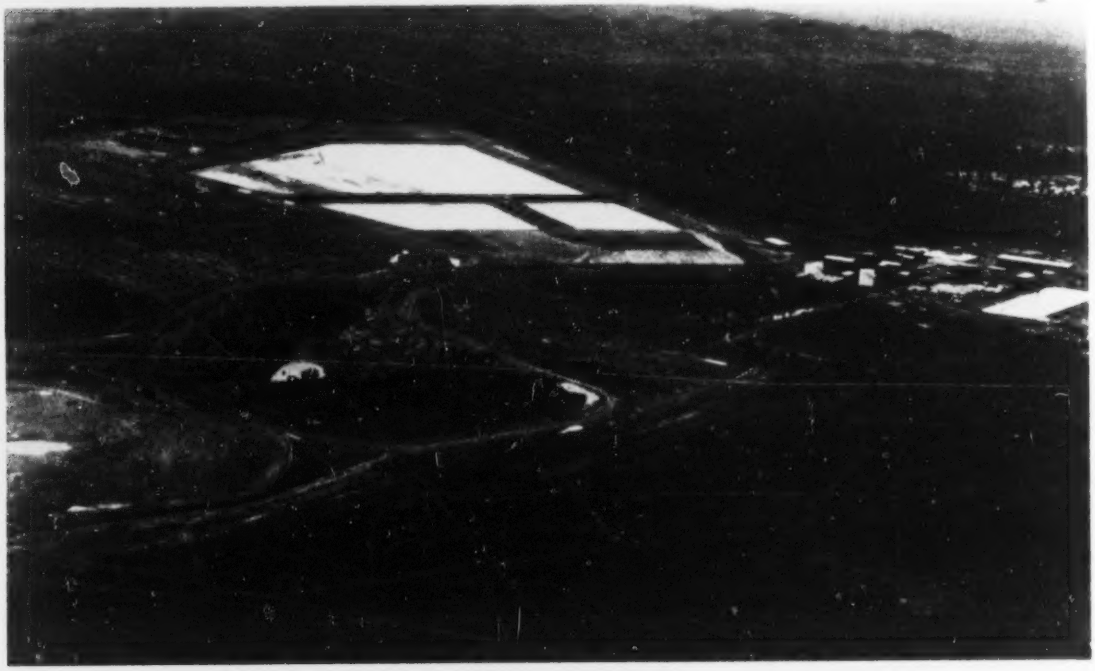

Figure 2. Another aerial view of Nabarlek, showing the mine pit in the foreground, left.

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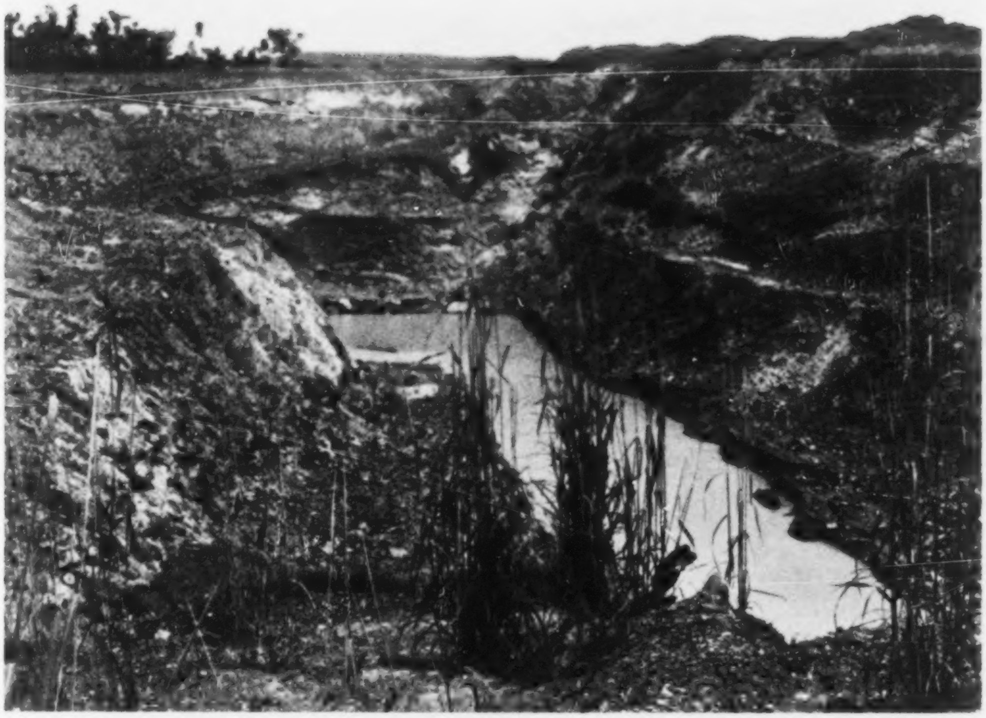

Figure 3. Close-up view of the mine pit. All mining has already been completed, and the pit will be used for final disposition of all mill tailings.

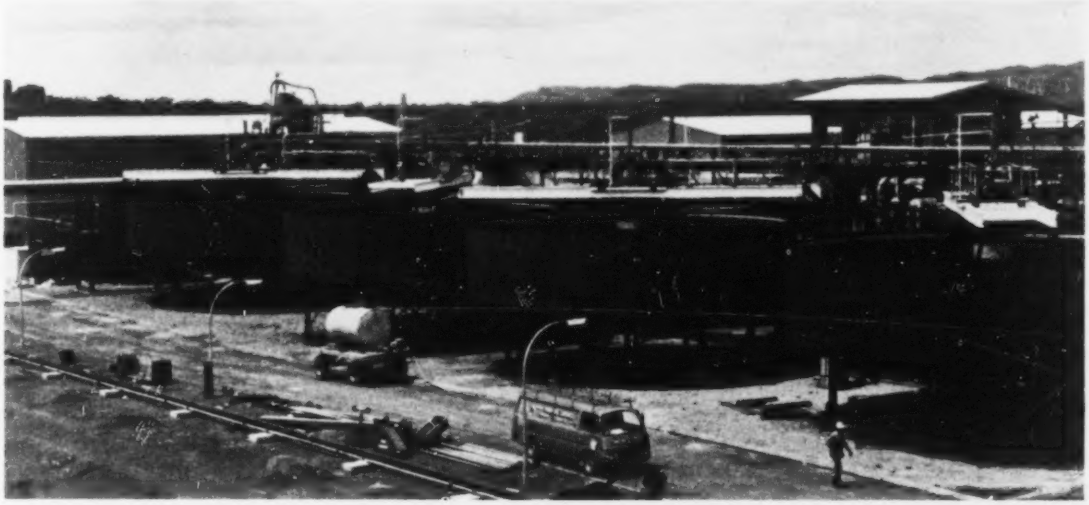

Figure 4. Close-up view of the mill site, with the thickeners in the foreground. Because of the very high grade of the Nabarlek ore (average grade is 2.35 percent U_3O_8), all mill components are relatively small.

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ships with suppliers of long standing, it can be expected that, like other buyers, the Japanese will evidence increasing sensitivity as their contract prices diverge from near-term price levels.

After negotiating with the government for some time, the Japanese private utilities were awarded rate increases effective April 1, 1980. Average nationwide residential rates in Japan will increase from 19.4 to 27.7 yen/kwhr, an increase of 43 percent. Average commercial/industrial rates will increase from 13.1 to 20.3 yen/kwhr, an increase of 54 percent. The increases are estimated to add about two percent to Japan's consumer price index, but are needed in part to offset the rising cost of fuel, and in part to finance the utilities' enormous capital investment program. For the fiscal year ending March 31, 1981, the total capital budget for the nine private utilities in Japan is about US $14,330,000,000.

United States

President Carter has apparently elected not to include the question of licensing of fuel movements in the restructuring of the US NRC which he proposed to Congress at the end of March. There had been some support for the idea of leaving nuclear export decisions solely to the US State Department. This concept was evidently too politically sensitive to include within the broader measures, and therefore, NRC's export licensing authority will remain unchanged.

Wyoming's legislature failed to pass both a 4% severance tax increase that had been proposed by the governor, and a Constitutional Amendment to raise taxes on uranium, coal, oil and natural gas. This is in contrast to New Mexico, as reported last month, where a severance tax increase was enacted.

The pattern of business in the near-term market continued as it has been since the first of the year. Volume of business transacted declined from last month, but the market is still made up of many sellers competing for a limited number of buyers. In the Market Opportunities Section of this Report (page 5.0) fourteen active inquiries are listed, involving more than 4,000,000 pounds U_3O_8 available for 1980 delivery. Only three inquiries to purchase are listed, involving a total of 1,000,000 lbs U_3O_8. There is virtually a total absence of US utility buyers for the 1980 delivery period. Further, there appears to be almost no interest among US utilities in buying for inventory. It is evident that the abnormally high interest rates in the US are contributing to the current price decline, as it becomes more and more expensive to hold inventory.

Several near-term transactions were completed in March. Price cutting by sellers was widespread, especially by those attempting to dispose of material already produced.

Pricing

The **Exchange Value** decreased again this month to $35.00 per pound U_3O_8, a drop of eight percent from last month. The reasons for the market weakness which resulted in this dramatic decline in price are summarized as follows:

—In 1979, US uranium production was about 37,000,000 pounds U_3O_8, while consumption (i.e. introduction of U_3O_8 into the enrichment-fabrication pipeline—see General Section of this Report for discussion) was approximately 25,000,000 pounds U_3O_8.

—In 1980, Nuexco expects that US production will be somewhat less than 37,000,000 pounds U_3O_8. US consumption for 1980 is expected to be about 28,500,000 pounds U_3O_8.

—Worldwide, the current situation is very similar to the US. Worldwide (outside Communist areas) production in 1979 is estimated at 98,500,000 pounds U_3O_8 compared with consumption of 68,700,000 pounds. The situation in 1980 is expected to be very similar to 1979.

—Thus in the US and the rest of the non-Communist world, uranium continues to be added to commercial inventories (i.e. the excess of production over consumption). US and total world inventory levels are already equal to about two and one-half to three years of forward consumption.

—Interest rates in the US are at record high levels. Prime lending rates of US banks are approaching 20 percent per annum, thus making the carrying of uranium inventory extremely expensive. The momentum in many US utilities is turning away from inventory buildup and toward inventory liquidation.

Inventories are playing a most important role in today's uranium market. The role is greater than

URANIUM MARKET

expected and the market reaction is more severe than expected. The outlook is for substantial correction of inventory imbalances before the market restabilizes.

Most new inventory buildup is involuntary, as long-term contracts require buyers to continue accepting material not immediately needed. Delays in actual need have occurred for a variety of reasons including schedule deferrals, licensing delays and, in some cases, outright cancellations. There has also been a simultaneous decrease in motivations which had earlier led users to policies encouraging voluntary buildup of inventory. High cost of money, need for cash, declining uranium prices, perceptions of ample supplies, and lowered projections of installed nuclear capacity have in the minds of most utilities helped create a more relaxed inventory policy.

In the view of a number of inventory holders, now is the time to begin to make adjustments. In some cases this entails the avoidance of any further inventory buildup. In other cases, it involves reducing inventories below current levels. In either case, the end result might be the forcing of previously purchased uranium into the current market.

Since most US utilities see the inventory problem in much the same way, none are now known to be intentionally adding to inventories. None, in fact, are known to be buying even for current needs. Uranium which comes back into the market, therefore, is of marginal interest to users. Any interest in purchasing on the near-term market is mainly on the part of producers. With utilities selling and producers buying, different market forces are in operation.

With the producer as buyer, the primary market consideration is a make-or-buy decision. The near-term market price level is thus determined by a new set of conditions. In order to make a sale to a producer, the seller must be willing to price its material at a level where it will be advantageous to the producer to purchase the material, cut back on its own production, and deliver the purchased material under an existing contract. Thus the market is faced with a situation in which the only available buyers have a very practical limit on the price they are able to pay. The limit is not related to supply and demand, competitive fuels, or other normal market factors. The decision is related more to the producer's cost of production. Since the only buyers in the market are faced with an economic limit on what they are able to pay, and since there is so much material for sale relative to current demand, it is not surprising that prices are rapidly decreasing.

The longer-term effect of the current price situation may be a weakening of the US producers' position in the world market. Low prices discourage expansion. Cutbacks in production will occur as a result of decisions to buy rather than make. Overseas producers which have cost leadership positions—as nearly all do in comparison to the US—will have their positions strengthened as a result of their improved ability to compete in the lower price market.

TOPICAL ESSAY

MARKETING AND PROCUREMENT: DELIVERY AND PAYMENT

Introduction

In the negotiation of the terms and conditions of a uranium contract, delivery and payment arrangements are probably second in importance only to price provisions. This essay will review these contract terms. At the outset, it must be recognized that there is no standard industry practice in this area. Practices within the US vary widely and tend to shift with changes in market dominance. Practices in South Africa, Australia, Canada and other export sellers are often different from US practice.

The terms "delivery" and "payment" cover a number of legal and commercial factors, each of which must be considered individually. They include:

—Passage of title
—Transfer of risk of loss
—Transfer of possession of the material
—Physical movement of the material
—Location of the material
—Invoicing
—Method of payment
—Time of payment
—Amount of payment

It should be recognized that passage of title, transfer of risk of loss, physical delivery, and payment do not necessarily take place simultaneously. In some instances all may occur at different locations and different points in time. The following examples, based on actual transactions, serve to illustrate the extremes.

1. A utility purchased an amount of U_3O_8 which a producer had in its storage account at a UF_6 conversion plant. Since the material had been weighed, sampled, assayed and accepted for conversion, delivery was effected by having the conversion contractor book transfer the exact quantity of material sold from the producer's storage account to the utility's conversion account. Title and risk of loss passed to the utility upon receipt of notification from the conversion contractor that the transfer was made. Payment was made the same day by wire transfer of immediately available funds to the producer's bank. This is the simplest and most straightforward type of transaction. Passage of title, transfer or risk of loss, physical delivery and payment all occurred on the same day.

2. A utility purchased an amount of U_3O_8 from a US producer. The material was located at the producer's mill, and payment, based on the producer's preliminary determination of weight and assay, was to be made thirty days after title transfer. The contract provided that title would transfer to the utility on the first day of the month. On the seventh of the month, the material was shipped from the producer's mill to Canada for conversion. The producer retained possession (through its transportation agent) and risk of loss while the material was in the US. The utility took possession (through its transportation agent) when the material crossed the US-Canadian border on the twentieth of the month. At that time, physical delivery by the producer was completed, but the producer retained risk of loss until the material was off-loaded at the conversion plant on the twenty-third of the month. The utility made payment to the producer on the thirtieth of the month (i.e. thirty days after title transfer). In this case, the principal events, passage of title, transfer of risk of loss, physical delivery and payment each occurred at a different time and in a different location.

Title

The method of transfer of title is usually explicitly agreed on by the buyer and seller in the sales contract. Title usually passes upon the occurrence of some specific event. Some events which have been used to trigger the transfer of title in uranium sales contracts are:

—Shipment from a producer's mill.
—Arrival or off-loading at a weighing and sampling facility, adjacent to a UF_6 conversion plant.
—Acceptance by a UF_6 conversion contractor for conversion.
—In a sale of UF_6, arrival or off-loading at an enrichment facility, or acceptance of the material for enrichment.
—In an export sale, arrival at the dock or airport, loading or off-loading of the ship or airplane, or border crossing.
—In a sale not involving movement, a book transfer by the party in possession of the material, such as a conversion contractor, US DOE or other enrichment contractor, or a storage facility.
—Receipt by buyer of notification that any of the

above events have occurred.

—Receipt by buyer of seller's invoice.

—Receipt by buyer of a document of title, such as a bill of lading, or a warehouse receipt.

The parties may also agree that title will pass on a specific date, or on a specific number of days after one of the above events, or some combination of an event and a date. Some sales contracts are silent on the passage of title. Under the US Uniform Commercial Code (which is law in every state in the US except Louisiana), title passes in any manner agreed on by the parties, but if there is no explicit agreement, Section 2-401 of the Code contains rules which govern the passage of title. Section 2-401 is reproduced for reference in the Appendix to this essay.

Risk of Loss

As the name implies, the party with risk of loss is the one which must suffer the financial burden of destruction of the material, such as in a shipwreck, or other loss of the material, such as by impoundment. Most sales contracts contain explicit provisions for the transfer of risk of loss in the material; such provisions usually apply only *as between the buyer and seller.* The party with physical possession of the material (e.g. a shipper, conversion contractor or storage facility), normally accepts the risk of loss under contract to the buyer or seller or both, and the party in possession usually covers risk of loss by an insurance policy.

Passage of risk of loss from seller to buyer is usually triggered by a specific event. Any of the events listed above which can trigger passage of title can also transfer risk of loss. It is important to recognize, however, that title and risk of loss do not have to pass at the same time. The contract may be arranged such that title will pass on the occurrence of one event, and risk of loss will pass on the occurrence of a later event. Or risk of loss may pass first, and title later. The Uniform Commercial Code has settled the issue in the US that a party does not have to have title to goods to bear the risk of loss in them.

Normally the buyer and seller will explicitly agree in the sales contract as to when risk of loss passes. In the absence of such an explicit agreement, the Uniform Commercial Code, Section 2-509, contains rules which govern passage of risk of loss. Section 2-509 is reproduced for reference in the Appendix to this essay.

Physical Delivery

Delivery, apart from passage of title and risk of loss, might involve both physical movement and change of possession of the material, or delivery may take place without moving the material. In the uranium industry, delivery is normally accomplished by one of the following methods:

Shipment to destination. The seller puts the material in possession of carrier (truck, rail, ship, or air) under a contract to ship the material to a specific destination. For example, a seller may complete physical delivery by loading the material aboard a truck at the millsite under a contract with the carrier to ship the material to a UF_6 conversion plant. Or in an export sale, the seller may complete physical delivery by loading the material aboard a ship under a contract with the carrier to ship the material to a specific port. Shipping cost may or may not be prepaid by the seller, depending on the agreement of the parties.

Delivery at destination. The seller completes delivery upon the arrival of the material at a specific destination. That destination is often a UF_6 conversion plant, or a storage facility, and delivery can be completed either by arrival of the carrier at the plant, or off-loading of the material from the carrier. In an export sale, delivery is often completed by the arrival or off-loading of the truck or rail carrier at the port of exit, or the arrival or off-loading of the ship or air carrier at the port of entry. Some export sales also involve physical delivery to a conversion plant or storage facility.

Delivery without movement. Some uranium sales involve delivery of the material without moving it. If the material is in the hands of a third party (e.g. a conversion contractor, storage facility, enrichment contractor, or other bailee), delivery without movement would normally require some form of acknowledgment by the third party of the buyer's rights in the material. For example, if delivery is to be made by book transfer at a conversion plant, it would usually be necessary for the conversion contractor to provide notification to the buyer that the transfer has been made to the buyer's account.

If delivery is to be made at the seller's mill, without moving the material, it would usually be necessary that the material be identified by the seller, and that the seller provide a document of title to the buyer.

Sections 2-503 and 2-504 of the Uniform Commercial Code cover delivery by the seller. These sections are reproduced for reference in the Appendix to this essay.

F.O.B. and C.I.F. Terms

The terms *F.O.B.* (free on board) and *C.I.F.* (cost, insurance and freight) are often used in uranium sales contracts. The term *F.O.B. place of shipment* normally means that the seller must place the material in the possession of the shipper, and bear the risk and expense of doing so. Thus a delivery F.O.B. place of shipment usually means that both physical delivery and passage of risk of loss occur at the time when the seller puts the material in the possession of the shipper.

The term *F.O.B. place of destination* normally means that the seller must transport the goods to the place of destination and bear the risk and expense of doing so. Thus a delivery F.O.B. place of destination usually means that both physical delivery and passage of risk of loss take place when the material arrives at the named destination.

The terim *C.I.F. destination* means that the price of the material includes the cost of freight and insurance to a named destination. Under a C.I.F. contract, the seller would put the material in the possession of the shipper under a contract to ship the material to the named destination. Normally, the seller would then send its invoice for the material to the buyer, accompanied by the bills of lading issued by the shipper, and the appropriate certificates of insurance.

Payment

Payment under a uranium sales contract is often triggered by the same event which causes the transfer of title to the buyer. It can also be triggered by delivery, by a combination of title transfer and delivery, or by the passage of a certain date. Normally, payment is effected by wire transfer of funds to the seller's bank on the specified payment date.

Except in very simple contracts, the Seller will usually be required to submit an invoice prior to payment. If payment is to be made on the basis of the seller's preliminary determination of weights and assays, there will be a provision in the contract for the buyer and seller to settle any differences after final weights and assays become available. Where provisional payments are made, sometimes only a portion of the seller's estimated invoice, usually 95 percent, is paid initially, with the balance due after final determination of uranium content. In some contracts, 100 percent of the seller's preliminary invoice is paid initially, with the seller or buyer making a final payment for any overage or shortfall, based on final weights and assays.

In export sales, payment is often made by letter of credit. The bank on which the letter of credit is drawn would be invoiced by the seller, and any documents evidencing delivery and/or title transfer would also be presented directly to the bank.

Some typical examples of payment provisions are:

—Payment due by wire transfer to seller's account within X days (e.g. 15 days, 30 days) after shipment of concentrates from the seller's mill, provided that buyer will have received notification that the material has arrived at the delivery location.

—Payment due by wire transfer within X days after receipt by buyer of both seller's invoice and notification from a conversion contractor that the material has been off-loaded at the weighing and sampling facility.

—Payment due by wire transfer within X days after receipt by buyer of Seller's invoice accompanied by bills of lading evidencing that the material has been loaded aboard a carrier (e.g. air, ship) under contract to ship the material to the agreed on destination.

APPENDIX

Sections of the Uniform Commercial Code on Title, Risk of Loss, and Delivery.

Section 2-401. Passing of Title; Reservation for Security; Limited Application of this Section.

Each provision of this Article with regard to the rights, obligations and remedies of the seller, the buyer, purchasers or other third parties applies irrespective of title to the goods except where the provision refers to such title. Insofar as situations are not covered by the other provisions of this

Article and matters concerning title become material, the following rules apply:

1. Title to goods cannot pass under a contract for sale prior to their identification to the contract (section 2-501), and unless otherwise explicitly agreed the buyer acquires by their identification a special property as limited by this chapter. Any retention or reservation by the seller of the title (property) in goods shipped or delivered to the buyer is limited in effect to a reservation of a security interest. Subject to these provisions and to the provisions of the Article on Secured Transactions (Article 9), title to goods passes from the seller to the buyer in any manner and on any conditions explicitly agreed on by the parties.

2. Unless otherwise explicitly agreed, title passes to the buyer at the time and place at which the seller completes his performance with reference to the physical delivery of the goods, despite any reservation of a security interest and even though a document of title is to be delivered at a different time or place; and in particular despite any reservation of a security interest by the bill of lading

a. if the contract requires or authorizes the seller to send the goods to the buyer but does not require him to deliver them at destination, title passes to the buyer at the time and place of shipment; but

b. if the contract requires delivery at destination, title passes on tender there.

3. Unless otherwise explicitly agreed where delivery is to be made without moving the goods

a. if the seller is to deliver a document of title, title passes at the time when and the place where he delivers such documents; or

b. if the goods are at the time of contracting already identified and no documents are to be delivered, title passes at the time and place of contracting.

4. A rejection or other refusal by the buyer to receive or retain the goods, whether or not justified, or a justified revocation of acceptance revests title to the goods in the seller. Such revesting occurs by operation of law and is not a "sale."

Section 2-503. Manner of Seller's Tender of Delivery

1. Tender of delivery requires that the seller put and hold conforming goods at the buyer's disposition and give the buyer any notification reasonably necessary to enable him to take delivery. The manner, time and place for tender are determined by the agreement and this Article, and in particular

a. tender must be at a reasonable hour, and if it is of goods, they must be kept available for the period reasonably necessary to enable the buyer to take possession; but

b. unless otherwise agreed, the buyer must furnish facilities reasonably suited to the receipt of the goods.

2. Where the case is within the next section respecting shipment tender requirements that the seller comply with its provisions.

3. Where the seller is required to deliver at a particular destination tender requires that he comply with subsection 1 and also in any appropriate case tender documents as described in subsections 4 and 5 of this section.

4. Where goods are in the possession of a bailee and are to be delivered without being moved

a. tender requires that the seller either tender a negotiable document of title covering such goods or procure acknowledgment by the bailee of the buyer's rights to possession of the goods; but

b. tender to the buyer of a non-negotiable document of title or of written direction to the bailee to deliver is sufficient tender unless the buyer seasonably objects, and receipt by the bailee of notification of the buyer's rights fixes those rights as against the bailee and all third persons; but risk of loss of the goods and of any failure by the bailee to honor the non-negotiable document of title or to obey the direction remains on the seller until the buyer has had a reasonable time to present the document or direction, and a refusal by the bailee to honor the document or to obey the direction defeats the tender.

5. Where the contract requires the seller to deliver documents

a. he must tender all such documents in correct form, except as provided in this Article with respect to bills of lading in a set (subsection 2 of section 2-323); and

b. tender through customary banking channels is sufficient and dishonor of a draft accompanying the documents constitutes non-acceptance or rejection.

Section 2-504. Shipment by Seller.

Where the seller is required or authorized to send the goods to the buyer and the contract does not require him to deliver them at a particular destination, then unless otherwise agreed he must

1. Put the goods in the possession of such a carrier and make such a contract for their transportation as may be reasonable having regard to the nature of the goods and other circumstances of the case; and
2. Obtain and promptly deliver or tender in due form any document necessary to enable the buyer to obtain possession of the goods or otherwise required by the agreement or by usage of trade; and
3. Promptly notify the buyer of the shipment.

Failure to notify the buyer under paragraph 3 or to make a proper contract under paragraph 1 is a ground for rejection only if material delay or loss ensues.

Section 2-509. Risk of Loss in the Absence of Breach

1. Where the contract requires or authorizes the seller to ship the goods by carrier
   a. if it does not require him to deliver them at a particular destination, the risk of loss passes to the buyer when the goods are duly delivered to the carrier even though the shipment is under reservation (section 2-505); but
   b. if it does not require him to deliver them at a particular destination and the goods are there duly tendered while in the possession of the carrier, the risk of loss passes to the buyer when the goods are there duly so tendered as to enable the buyer to take delivery.
2. Where the goods are held by a bailee to be delivered without being moved, the risk of loss passes to the buyer
   a. on his receipt of a negotiable document of title covering the goods; or
   b. on acknowledgment by the bailee of the buyer's right to possession of the goods; or
   c. after his receipt of a non-negotiable document of title or other written direction to deliver, as provided in subsection 4(b) of Section 2-503.
3. In any case not within subsection 1 or 2, the risk of loss passes to the buyer on his receipt of the goods if the seller is a merchant; otherwise the risk passes to the buyer on tender of delivery.
4. The provisions of this section are subject to contrary agreement of the parties and to the provisions of this Article on sale on approval (section 2-327) and on effect of breach on risk of loss (section 2-510).

Quartz-pebble Conglomerates—Part I

Introduction

Uranium mineralization is present in almost every occurrence of quartz-pebble conglomerate throughout the world.

The conglomerates in the Elliot Lake district of Ontario, Canada, and the Witwatersrand district of the Republic of South Africa contain uranium in economically recoverable amounts. The uranium contained in the conglomerates of these two districts represents about 25 percent of the world's known reserves. The recoverable uranium reserves of the presently defined Elliot Lake district are roughly estimated at nearly 1,000,000,000 pounds U_3O_8. Perhaps even more impressive is the fact that the largest single ore deposit identified to date at Elliot Lake (the Quirke zone) contains over 600,000,000 pounds U_3O_8, making it one of the largest uranium deposits ever discovered.

Uranium was first recovered as a by-product of gold production from the Witwatersrand conglomeritic reefs (mineralized beds) in 1952, and as the primary mineral in the Elliot Lake reefs in 1954. Production from both districts has continued since then. Total uranium production to date from quartz-pebble conglomerates is 225,000,000 pounds U_3O_8 in South Africa and 210,000,000 pounds U_3O_8 in Canada. Over 99 percent of all uranium currently being produced in South Africa, and about 60 percent of that currently being produced in Canada, is from quartz-pebble conglomerates.

The uranium potential of conglomerates in other countries is being evaluated at this time, including Jacobina (Brazil), Rum Jungle (Australia), Karnataka (India) and Tarkwa (Ghana). Other areas of interest are southwestern Russia, northern Finland and the western US. Figure 5 is a world map showing the location of Early Proterozoic uraniferous quartz-pebble conglomerates and related sediments.

Genesis of Quartz-Pebble Conglomerates

Most uranium-bearing quartz-pebble conglomerates are restricted to rocks of Early Proterozoic age, about the middle of the Precambrian Era. Quartz-pebble conglomerates are time-bound between older Archean rocks, which are not known to contain economically recoverable uranium deposits, and Middle Proterozoic rocks which contain both unconformity-related and vein deposits. (e.g. Saskatchewan and the Northern Territory of Australia). Table 4 has been prepared to illustrate this geologic relationship.

Table 4
URANIUM OCCURRENCES IN PRECAMBRIAN SUBDIVISIONS

Subdivision	Age (millions of years)	Uranium Occurrences
Late Proterozoic	900-570	
Middle Proterozoic	1600-900	Unconformity, vein
Early Proterozoic	2500-1600	Quartz-pebble conglomerates
Late Archean	2900-2500	
Middle Archean	3300-2900	
Early Archean	more than 3300	

The majority of uranium-bearing conglomerates, especially those in South Africa and Canada, are restricted to the depositional period of the first half of the Early Proterozoic age. The geologic changes which took place during the extremely long transition from Archean through Early Proterozoic were dramatic. During this time, there was a marked increase in global tectonic activity resulting in an obvious change in the depositional sequence of different types of clastic sediments in structural basins. The quartz-pebble conglomerates were among the first clastics to be deposited—in some instances, directly upon Archean metamorphic and granitic rocks. The coarse fraction was rapidly deposited along the edges of catchment basins. The finer fraction was transported basinward by coalescing stream action to accumulate in blanket deposits many meters thick. Such depositional patterns resulted in characteristic placer deposits with the largest rock and heavy mineral constituents deposited closer to the source areas. The greatest accumulation of minerals was along the basin-fringe area, as in the Witwatersrand district, which contains gold and uranium, and the Elliot Lake district, which contains uranium.

The physical characteristics of both districts are similar, as are their ages. The conglomerates are generally composed of 70 to 85 percent quartz-pebbles and 15 to 25 percent vein quartz, chert and quartz porphyry pebbles. Uranium mineralogy is primarily uraninite at Witwatersrand and brannerite

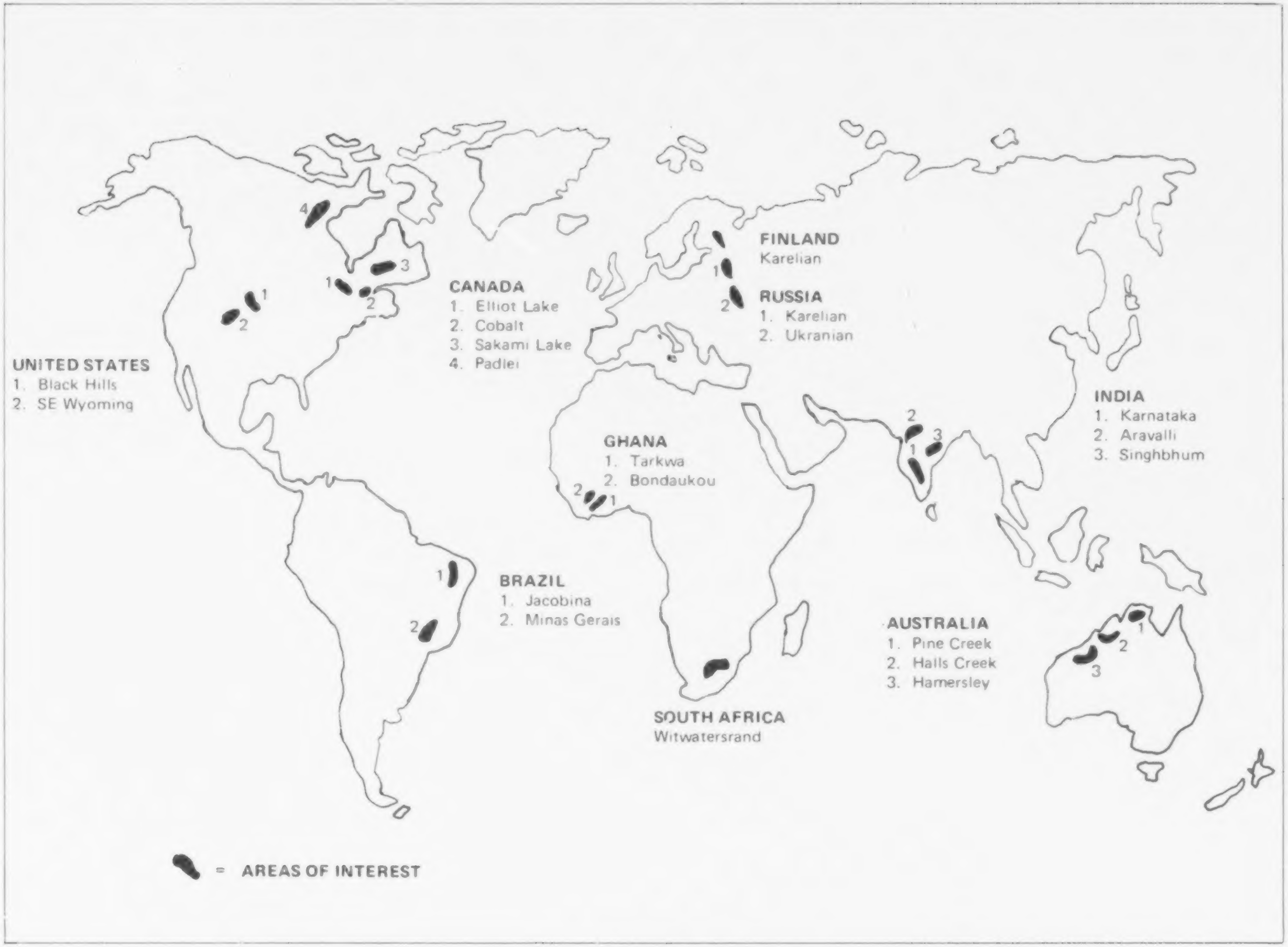
UNITED STATES
1. Black Hills
2. SE Wyoming
CANADA
1. Elliot Lake
2. Cobalt
3. Sakami Lake
4. Padlei
FINLAND
Karelian
RUSSIA
1. Karelian
2. Ukranian
INDIA
1. Karnataka
2. Aravalli
3. Singhbhum
GHANA
1. Tarkwa
2. Bondaukou
BRAZIL
1. Jacobina
2. Minas Gerais
AUSTRALIA
1. Pine Creek
2. Halls Creek
3. Hamersley
SOUTH AFRICA
Witwatersrand
= AREAS OF INTEREST

Figure 5.
LOCATION MAP OF WORLD-WIDE OCCURRENCES OF EARLY PROTEROZOIC QUARTZ-PEBBLE CONGLOMERATES AND RELATED SEDIMENTS.

at Elliot Lake, although both minerals are known to occur in each district. The uranium occurs as a small portion of the conglomerate matrix, which may contain 15 to 20 percent pyrite and an assortment of other minerals, most of which are not economically recoverable.* All rock and mineral products making up the conglomerate originated from Archean basement rocks. The contained minerals are considered to be detrial, or placer, in origin.

Genesis of Ore Minerals

Not all conglomeritic units are mineralized. Mineral-bearing units often occur in multiple or stacked zones. They may be separated by barren conglomerate, quartzite or sandstone units which vary in thickness from a few centimeters to many meters. The minerals are generally localized along unconformable contacts with lower barren units; otherwise, all conglomeritic units have similar depositional characteristics. This supports the theory that significant geologic changes occurred during Late Archean/Early Proterozoic time.

The origin of the conglomerates and associated mineralization has been controversial. There are two principal theories—the minerals are either syngenetic or epigenetic. The favored theory of ore genesis is syngenetic, whereby the ore minerals are derived from Archean rocks, transported and deposited with the quartz-pebble conglomerates, forming what is known as a placer deposit. The ore minerals and the quartz-pebbles are well-rounded and well-sorted, indicating movement basinward from adjacent highlands into stream channels, with coalescing depositional patterns. There is also evidence of redistribution by wave action prior to burial and compaction. All constituents within the conglomeritic units are considered to be syngenetic—the ore minerals and the quartz-pebbles were deposited contemporaneously and probably from the same source area. Uranium, gold and pyrite are part of the heavy mineral fraction concentrated near the base of mineralized conglomerate and/or within topographic depressions formed on the Archean erosion surface.

The relationship between the specific gravity of the heavy minerals and the size of the particles (2.0 mm down to 0.01 mm) also supports the placer theory. Gold is the heaviest mineral and, at the Witwatersrand, it shows greater concentration near the source area than either uranium or sulfide minerals. The mineral mix is moderate to fine gold with coarse uranium and pyrite, moderate to fine uranium with coarse pyrite. Further basinward, the mix is mainly fine pyrite with only a trace of uranium and perhaps no gold at all. The depositional pattern is similar at Elliot Lake, but without the gold.

The age of the ore minerals at the Witwatersrand further supports the placer theory. The Witwatersrand sequence rests unconformably upon Archean granites, restimated to be Middle to Late Archean. the ore minerals in the lower conglomerates have been dated to 3100 to 3000 million years, while the Witwatersrand sequence has been dated to about 2800 to 2300 million years.

The epigenetic origin of the ore minerals relates to the theory that the minerals precipitated from mineral-bearing hydrothermal solutions emanating from Archean rocks, and were introduced into the conglomerates. Supporting evidence of hydrothermal origin are the following: the occasional occurrence of irregularly shaped gold nuggets; the partial replacement of quartz-pebbles by pyrite; and veinlets of gold-cutting quartz-pebbles and pyrite grains—common hydrothermal characteristics. This suggests that the deposits are at least modified placers and the minerals may be epigenetic.

Geologic evidence definitely favors the syngenetic theory of ore genesis. However, consideration should be given to geologic change and the effect it has had on ore minerals—a local situation. There is evidence in the Witwatersrand reefs showing that a small amount of uranium has been redistributed and recrystalized due to continued structural movement and metamorphism. The uranium minerals at both Elliot Lake and Jacobina, Brazil show evidence of alteration and mobilization. It is likely that the changes took place during a long period of metamorphosis. In fact, brannerite, the primary uranium mineral at Elliot Lake, shows alteration characteristics which indicate the mineral may be of epigenetic origin—at least locally. Overall, the genesis of the uranium minerals in the quartz-pebble reefs is considered to be syngenetic.

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*Rare earths are recovered as a by-product to uranium in the Elliot Lake district.

Epigenetic minerals have formed locally due to geologic changes.

Ore Values

The uranium content in the quartz-pebble reefs is relatively low compared to the unconformity and vein deposits of Middle Proterozoic age, and the sandstone deposits of Mesozoic age. The average grade of uranium recovered along with gold at the Witwatersrand is in the range of 0.01 percent to 0.03 percent U_3O_8. The average grade of ore at Elliot Lake varies from about 0.07 percent to 0.15 percent U_3O_8. Occasionally, higher grade zones are encountered during mining, especially at Elliot Lake.

STATISTICAL DATA

EXCHANGE VALUE—$35.00/lb U_3O_8
Determined as of March 31, 1980

DEFINITION

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

COMMENTS

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of March 31, 1980

$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
38.60	3.6	11	3

DEFINITION

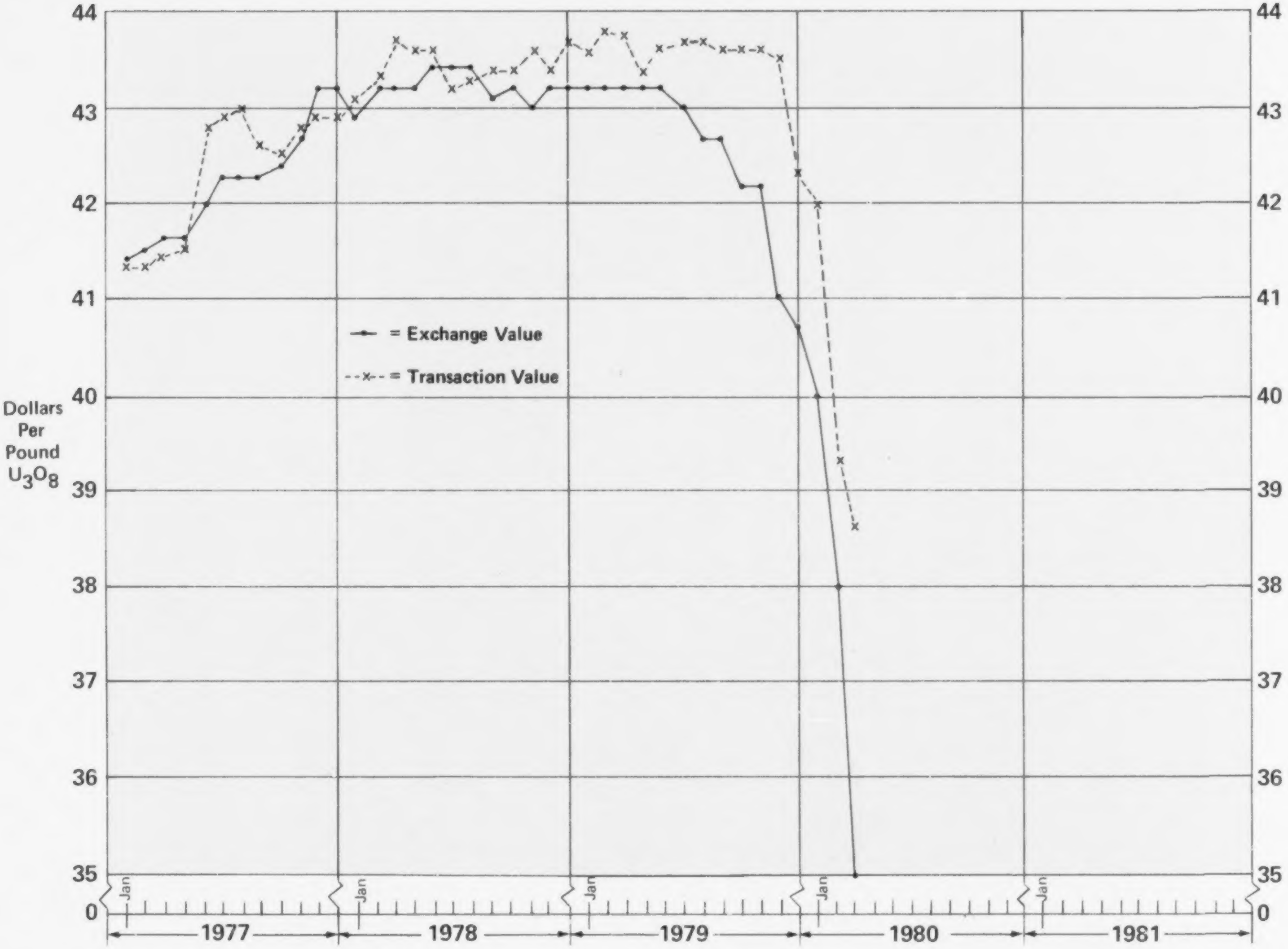
The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

NUEXCO

EXCHANGE AND TRANSACTION VALUES SINCE JANUARY 1977

Determined as of the last day of the month indicated

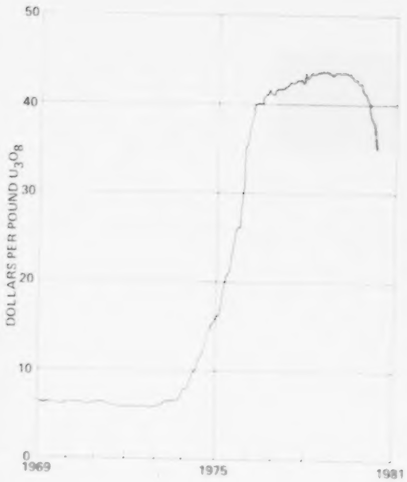
US Dollars/lb. U_3O_8



HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated

US Dollars/lb. U_3O_8



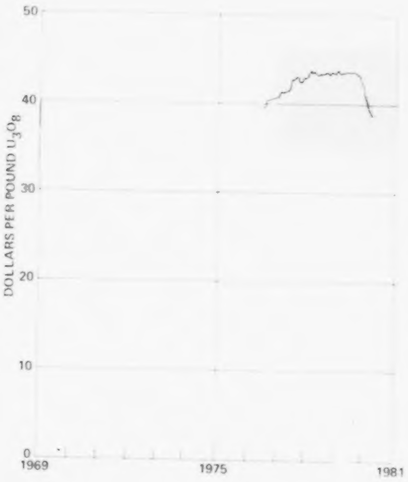
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00									

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated

US Dollars/lb. U_3O_8



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60									

Note: See Nuexco Report No. 135, dated October 31, 1979, for a discussion of the definition of Transaction Value.

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	35.00	77.16	90.99
France (franc)	155.76	343.40	404.95
FRG (mark)	67.55	148.93	175.63
Japan (yen)	8,726	19,238	22,686
Switzerland (franc)	64.09	141.30	166.62
UK (pound)	16.06	35.41	41.76
Australia (dollar)	32.26	71.12	83.86
Canada (dollar)	41.55	91.61	108.03
Niger, Gabon (CFA)	7,788	17,170	20,247
South Africa (rand)	28.34	62.48	73.68

* Calculated using currency exchange rates published in the Wall Street Journal on the last business day of the month.

LOAN USE CHARGE RATE — 7.0%/year

DEFINITION

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Nuexco Ref Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as percent of Current E.V.	Seller Group	Buyer Group	Remarks
1070	80	100 to 300	–	US	US	Loan – Repayment in 1981
1071	80	100 to 300	101	US	US	
1081	thru 91	7,000 to 10,000	–	Africa	Far East	Price related to market at time of delivery
1090	80	Less than 50	102	US	US	
1093	80	300 to 600	92	Europe	US	Enriched UF_6

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* Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 100)(1)	Consumer Price Index (1967 = 100)(2)	GNP Implicit Price Deflator (1972 = 100)(3)	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)(4)		
				Metal Mining (SIC 10)	**Primary Non-ferrous Metals (SIC 333)**	**Chemicals and Allied Products (SIC 28)**
Annual Avg. 1970(5)	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971(5)	114.0	121.3	96.02	4.12	4.15	3.94
Annual Avg. 1972(5)	117.9	125.3	100.00	4.49	4.59	4.21
Annual Avg. 1973(5)	125.9	133.1	105.80	4.82	4.98	4.48
Annual Avg. 1974(5)	153.8	147.7	116.02	5.43	5.63	4.85
Annual Avg. 1975(5)	171.5	161.2	127.15	6.13	6.24	5.37
Annual Avg. 1976(5)	182.3	170.5	133.71	6.75	6.87	5.89
Annual Avg. 1977(5)	195.1(4)	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978(5)	209.4	195.4	152.05	8.23	8.56	7.01
Dec 1978	217.2	202.9	156.68	8.72	8.97	7.28
Jan 1979	220.0	204.7	—	8.71	9.01	7.32
Feb 1979	222.5	207.1	—	8.81	9.02	7.32
Mar 1979	225.4	209.1	160.22	8.84	9.11	7.36
Apr 1979	229.0	211.5	—	9.03	9.49	7.50
May 1979	231.6	214.1	—	9.06	9.15	7.47
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9	—	9.32	9.57	7.60
Aug 1979	240.6	221.1	—	9.38	9.70	7.65
Sep 1979	244.2R	223.4	167.20	9.63	9.79	7.73
Oct 1979	248.5	225.4	—	9.67	9.87	7.82
Nov 1979	250.2	227.5	—	9.79	9.86	7.87
Dec 1979	252.8	229.9	170.71P	9.81	9.92	7.91
Jan 1980	260.3	233.2	—	9.94P	10.09P	7.94P
Feb 1980	265.4	236.4	—	—	—	7.95P

P = Preliminary R = Revised since last month

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. All data for 1977 and beyond are adjusted to the most recent benchmark — March 1978 — and are subject to revision from that point forward with the advent of the next benchmark scheduled for publication in late 1980.

(5) Data for these years, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Report No. 139, dated March 1980.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000)[1], [2] (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings ($C)[3], [4]		
		Metal Mining, including milling (SIC 050-059)	**Primary Metal Industries, non-ferrous (SIC 296-298)**	**Chemicals and Chemical Products (SIC 370-379)**
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Nov 1978	198.6	9.18	7.09	7.14
Dec 1978	199.4	9.29	6.93	7.14
Jan 1979	204.8	9.19	7.14	7.29
Feb 1979	208.5	9.24	7.18	7.36
Mar 1979	210.4	9.47	7.20	7.51
Apr 1979	212.8	9.68	7.26	7.63
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3	9.37	7.34	7.73
Aug 1979	220.0	9.56	7.38	7.77
Sep 1979	223.4	9.75	7.50	7.81
Oct 1979	227.4R	10.03	7.54	7.88
Nov 1979	228.1	9.97	7.61	7.91
Dec 1979	230.3R	9.90P	7.50P	7.90P
Jan 1980	238.0P	—	—	—

P = Preliminary
R = Revised since last month

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 4.10 of Report No. 138, dated January 31, 1980.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 4.11 of Report No. 138, dated January 31, 1980.

STATISTICAL DATA

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry – All Groups (Year 1968-69 = 100.0)(1)	Weighted Average Minimum Weekly Wage Rates – Adult Males Australia Mining and Quarrying (A$)(2)
Annual Avg. 1970(3)	101.4	59.88
Annual Avg. 1971(3)	101.5	65.95
Annual Avg. 1972(3)	105.6	71.26
Annual Avg. 1973(3)	124.4	78.96
Annual Avg. 1974(3)	141.9	108.07
Annual Avg. 1975(3)	150.4	132.55
Annual Avg. 1976(3)	168.4	160.93
Annual Avg. 1977(3)	192.0	179.03
Annual Avg. 1978(3)	215.4	190.04
Oct 1978	230.3	190.56
Nov 1978	232.2	190.86
Dec 1978	235.7	199.28R
Jan 1979	246.3	199.79R
Feb 1979	253.0	200.00
Mar 1979	264.0	201.45R
Apr 1979	273.0	202.27
May 1979	287.5	203.38R
Jun 1979	293.8	209.88R
Jul 1979	295.8	210.49R
Aug 1979	290.8	211.56
Sep 1979	300.0	212.34R
Oct 1979	307.0	211.80R
Nov 1979	308.0P	211.12P
Dec 1979	317.0P	–

P = Preliminary
R = Revised since last month

(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

(2) Australian Bureau of Statistics, Canberra; "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest twelve months shown are subject to revision.

(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Report No. 138, dated January 31, 1980.

STATISTICAL DATA

REPUBLIC OF SOUTH AFRICA STATISTICS

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)(1)	Consumer Price Index(2) (1975 = 100, except where otherwise indicated)
Annual Avg. 1970(3)	7.34	100.3(4)
Annual Avg. 1971(3)	7.88	106.4(4)
Annual Avg. 1972(3)	8.79	113.3(4)
Annual Avg. 1973(3)	10.51	124.1(4)
Annual Avg. 1974(3)	13.18	138.5(4)
Annual Avg. 1975(3)	16.71	157.2(4)
Annual Avg. 1976(3)	19.30	174.7(4)
Annual Avg. 1977(3)	23.87	194.4(4)
Annual Avg. 1978(3)	27.14	137.2
Annual Avg. 1979(3)	30.18	155.3
Jan 1979	–	145.3
Feb 1979	–	146.1
Mar 1979	28.60	148.6
Apr 1979	–	149.9
May 1979	–	150.6
Jun 1979	29.44	152.4
Jul 1979	–	157.9
Aug 1979	–	160.2
Sep 1979	30.71	162.1
Oct 1979	–	162.9
Nov 1979	–	163.4
Dec 1979	31.89	164.0
Jan 1980	–	165.4
Feb 1980	–	167.0

(1) Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly.

(2) Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Index for Urban Areas."

(3) Historical data for 1970 through 1979 appear on page 4.9 of Report No. 140 of April, 1980.

(4) April 1970 = 100.00

STATISTICAL DATA

REPUBLIC OF SOUTH AFRICA STATISTICS

Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]

Quarter Ending	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970
March	28.60	26.70	23.02	18.51	15.64	11.98	9.39	8.49	7.65	7.28
June	29.44	26.19	23.19	19.06	16.40	12.60	10.29	8.66	7.84	7.32
Sept	30.71	27.41	23.85	19.39	17.05	13.73	10.95	8.83	7.91	7.34
Dec	31.89	28.23	25.37	20.25	17.69	14.41	11.36	9.17	8.12	7.43
Annual Average	30.18	27.14	23.87	19.30	16.71	13.18	10.51	8.79	7.88	7.34

Consumer Price Index – Urban Areas[2]

Month	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970
	(1975 ann. avg. = 100)		(. . . . . . . April 1970 = 100 for 1970 through 1977 . . . .)							
Jan	145.3	130.2	183.8	166.0	149.0	129.3	118.7	109.6	102.7	–
Feb	146.1	131.3	186.7	166.8	150.4	131.1	119.8	110.0	102.8	–
Mar	148.6	131.9	188.7	168.8	151.4	133.2	121.5	110.5	103.6	–
Apr	149.9	133.0	190.5	170.9	153.5	134.0	122.3	111.0	105.1	100.0
May	150.6	133.6	191.7	172.6	154.7	134.8	122.9	111.8	105.8	100.1
Jun	152.4	134.2	193.3	174.1	156.7	137.2	123.4	112.2	106.5	100.4
Jul	157.9	139.8	195.4	175.6	158.3	139.2	124.3	113.2	107.1	100.8
Aug	160.2	140.6	197.9	177.8	159.9	141.5	125.0	114.4	107.5	101.1
Sep	162.1	141.8	199.5	179.3	161.0	143.5	126.1	115.8	108.0	101.6
Oct	162.9	142.6	200.7	180.5	162.4	144.7	127.4	116.6	108.7	102.1
Nov	163.4	143.1	201.7	181.0	163.9	146.0	128.5	116.6	109.0	102.1
Dec	164.0	143.8	202.6	182.4	164.6	147.3	129.1	117.4	109.4	102.3
Annual Average	155.3	137.2	194.4	174.7	157.2	138.5	124.1	113.3	106.4	100.3

(1) Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly.

(2) Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Price Index for Urban Areas."

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

SUPPLY

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8)				Remarks
	1980	1981	1982	1983	
Uranium Available for Sale:					
1213	1000				
1236	200	200	200		
1274	150	800	800		
1284	250				
1286	350	150	150	150	
1306		100	200	200	
1315			200	200	
1324		500	500	500	
1325	750				
1333	350	250	250		
1338	250				
1345	50				
1346	100				
1377	50				
1392	200				
1394	100				
1395	250				
TOTALS	4050	2000	2300	1050	
Uranium Available for Loan:					
1136	1000				UF_6
1136A	350				
1175	700				UF_6
1234	700				
1354	600				UF_6
1355	600				
1383	1000				
TOTAL	4950				

MARKET OPPORTUNITIES

DEMAND

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8)				Remarks
	1980	1981	1982	1983	
Inquiries to Purchase:					
1146		100	200	200	
1260		800			
1321			400	400	
1335	500				
1357		300			
1380	400				
1381	100				
TOTALS	1000	1200	600	600	
Inquiries to Borrow:					
1220	1000				
1348	350				
TOTAL	1350				

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NUEXCO

MONTHLY REPORT
ON THE URANIUM MARKET

NO. 141

MAY 1980

NUEXCO
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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT NO. 141

The **Exchange Value** dropped again this month to $32 per pound U_3O_8, from $35 last month. It has decreased a total of $8 over the last three months. The liquidation of uranium inventory by users continues to contribute to the price decline. However, this is just a symptom of the underlying problem—there is much more uranium being produced in the world than is being consumed. (Nuexco defines consumption as uranium entering the enrichment-fabrication pipeline for later use in a reactor.) In 1979, world production was about 30 million pounds U_3O_8 in excess of consumption. The same is expected in 1980. Although the gap is expected to begin closing after 1980, the cumulative world excess of production over consumption for the years 1979 through 1983 is estimated by Nuexco to be about 135 million pounds U_3O_8. This is notwithstanding a downward revision of Nuexco's estimated world production, which reflects the current weak uranium market.

The revised estimate of world production is included in the **General** section of this Report. The biggest changes from the last Nuexco estimates, published in Reports 133 and 134, are in US production. Due to weakening prices, Nuexco now expects US production to decline from its present level.

Spot market activity slowed during April. There was a substantial gap between bids and offers during most of the month, so few transactions were actually concluded. Uranium available for sale in 1980 was about double that sought through inquiries. Most of the current inquiries in the near-term market are from producers.

Falling price has increased the marketing difficulties faced by **Australian** sellers, as the spot price approaches the minimum levels set by their government when prices were both higher and more stable.

The status of nuclear power in several nations in **Europe** and the **Far East** is reviewed in this Report.

A *Commentary* section is introduced in this Report. This month's commentary deals with the subject of national decision making.

The *Raw Materials* section concludes a two-part series on uranium occurrence in quartz-pebble conglomerates. This month's discussion focuses on the Witwatersrand district of **The Republic of South Africa** and the Elliot Lake district of **Canada**.

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5/80

NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

No. 141 May 1980

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FOREWORD

Nuexco hosted a luncheon at the AIF Fuel Cycle Conference in New Orleans on April 16. Bob Wolcott and Jim Vaughan of the Nuexco staff delivered some comments on the current state of the uranium market. Copies of their remarks are enclosed with this Report.

In this Report, we are introducing a *Commentary* section. This month's commentary is on the subject of national decision making.

URANIUM MARKET

GENERAL

Estimate of World Uranium Production

Nuexco presented estimates of US and world production of U_3O_8 in Reports 133 and 134. Those estimates were developed under the assumption that the economics of uranium production would remain relatively favorable. Since that time, the uranium market has substantially weakened. That decline in the market has been especially severe on uranium producers in the US, where average production costs for many producers is at or above the current Exchange Value.

Under the conditions prevailing in today's uranium market, it is unlikely that projects not yet under construction will go forward. Consequently, Nuexco has prepared an estimate of world uranium supply based only on facilities which are operating or under construction as of April 30, 1980. In the US, some existing facilities have begun to reduce production. Some can be expected to suspend production within the next one to three years if present trends continue. The estimate of US uranium production presented in this Report is based upon Nuexco's assessments of the probable output of each producer, which in turn is based upon estimated production cost, ore reserves, and sales commitments.

Production centers are divided into categories, according to stage of development, as follows:

1. Operating production centers—those which have shipped U_3O_8 in commercial quantities before May 1, 1980.
2. Production centers under construction—those which were being built as of May 1, 1980, and which have an established access to ore reserves. Conventional production centers are included in this category only if mill construction has actually begun.

Each category is further divided, according to source, as follows:

—Conventional milling
—Unconventional recovery methods
  - Solution mining, including *in situ* leaching and hydraulic mining.
  - Phosphoric acid by-product recovery.
  - Heap leaching, including leachings of tailings and copper dumps.

Operating US production centers are listed in Table 1. Centers under construction are listed in Table 2. Table 3 summarizes the estimated U_3O_8 production for each category. The annual totals through 1986 constitute Nuexco's current judgment of output from the US uranium production sector. Estimates are also included for 1990 as indicators of production which can be foreseen today.

Actual US uranium production was about 37 million pounds U_3O_8 in 1979, falling short of Nuexco's previous estimate by one million pounds. The difference is largely attributable to an unanticipated decline in mill utilization. Annual US production from existing facilities is expected to decline from the 1979 level of 37 million pounds U_3O_8 to about 23 million pounds in 1986. The decrease is due to declining ore grades, depletion of orebodies and production cutbacks due to high costs. Total US production is expected to be 27 million pounds in 1986.

Since Nuexco Report 133 was published, four production centers have begun operating (all unconventional) and three have begun construction. However, three unconventional production facilities have since terminated operations and several conventional mills have reduced daily throughput of ore below rated capacity.

Non-US production centers included in this estimate are listed in Table 4. Conventional production facilities are included only if the mill is operating or under construction. Table 5 tabulates estimated world uranium production by region; Table 6 contains the same production estimates segmented according to status of the production center. World production for 1979 totalled approximately 99 million pounds U_3O_8, of which non-US production accounted for 62 percent. Table 5 shows the US portion of the world's uranium production declining steadily from its present level of 38 percent.

URANIUM MARKET

Table 1
OPERATING US PRODUCTION CENTERS

CONVENTIONAL MILLS

- Anaconda Corp.; Grants, NM
- Atlas Minerals Corp.; Moab, UT
- Chevron Resources; Pannamaria, TX
- Conoco-Pioneer Nuclear JV; Falls City, TX
- Cotter Corp; Canon City, CO
- Dawn Mining Co.; Ford, WA
- Exxon Minerals Co. USA; Powder River Basin, WY
- Federal American Partners; Gas Hills, WY
- Kerr-McGee Nuclear; Grants, NM
- Pathfinder Mines Corp.; Gas Hills, WY
- Pathfinder Mines Corp.; Shirley Basin, WY
- Petrotomics Co.; Shirley Basin, WY
- Rio Algom Corp.; La Sal, UT
- Rocky Mountain Energy; Bear Creek, WY
- Sohio-Reserve; Seboyeta, NM
- Union Carbide Corp.; Uravan, CO
- Union Carbide Corp.; Gas Hills, WY
- United Nuclear Corp.; Church Rock, NM
- United Nuclear-Homestake Partners; Grants, NM
- Western Nuclear, Inc.; Jeffrey City, WY
- Western Nuclear, Inc.; Sherwood, WA

UNCONVENTIONAL SOURCES

Solution Mining:

- Kaneb Assoc.-Everest Exploration; Hobson, TX
- Mobil Oil Corp.; Holiday El Mesquite, TX
- Mobil Oil Corp.; Bruni, TX
- Uranium Resources Corp.; Bruni, TX
- Uranium Resources-Framco-Conoco JV; Benevedes, TX
- US Steel Corp.; George West, TX
- US Steel-NM Uranium; Clay West, TX
- Wyoming Mineral Corp.; Iragary, WY
- Wyoming Mineral Corp.; Bruni, TX
- Wyoming Mineral Corp.; Ray Point, TX

Phosphoric Acid By-product:

- Freeport Uranium Recovery Corp.; Uncle Sam, LA
- Gardinier, Inc.; Tampa, FL
- IMC Corp.; New Wales[1]
- Wyoming Mineral Corp.; @Farmland Industries, Pierce, FL

Heap Leaching:

- Anamax Mining Co.; Sahuarita, AZ
- Solution Engineering, Inc.; Falls City, TX
- Union Carbide Corp.; Maybell, CO
- Wyoming Mineral Corp.; Bingham, UT

---

[1] Start-up phase in progress. Scheduled to commence commercial operations May 1980.

Table 2
US PRODUCTION CENTERS UNDER CONSTRUCTION

CONVENTIONAL MILLS

- Bokum Resources; Marquez, NM
- Energy Fuels; Blanding, UT
- Minerals Exploration; Sweetwater, WY
- Plateau Resources; Shootering Canyon, UT

UNCONVENTIONAL SOURCES

Solution Mining:

- Mobil Oil Corp.; Nell, TX
- Mobil Oil Corp.; Piedre Lumbre & Brelum, TX

Phosphoric Acid By-product:

- Earth Sciences; Calgary, Alberta[2]
- Freeport Uranium Recovery Corp. @ Agrico; Faustina, LA
- IMC Corp. @CF Industries; Plant City, FL
- IMC Corp. @CF Industries; Bartow, FL

---

[2] P_2O_5 is made from US phosphate rock, so U_3O_8 recovered is deemed to be of US origin.

Table 3
ESTIMATED US URANIUM PRODUCTION
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1990
Operating:									
Conventional Mills	33.4	29.5	26.7	25.7	24.2	21.0	20.9	19.0	18.5
Unconventional Sources	3.6	5.6	5.9	6.3	5.8	5.3	5.0	4.0	3.8
Subtotal	37.0	35.1	32.6	32.0	30.0	26.4	25.9	23.0	22.3
Under construction:	—0—	0.7	2.4	2.9	3.4	3.8	3.8	3.8	3.8
TOTAL (rounded to nearest million)	37	36	35	35	33	30	29	27	26

Table 4
OTHER PRODUCTION CENTERS
(outside Communist areas)

Country	Status	Operating Company (Deposit)
Australia	OP	Mary Kathleen Uranium (Mary Kathleen)
	OP	Queensland Mines Ltd. (Nabarlek)
	UC 82	Ranger Uranium Mines (Jabiru)
Canada	OP	Denison Mines, Ltd. (Elliot Lake)
	OP	Eldorado Nuclear, Ltd. (Beaverlodge)
	OP	Gulf Minerals Canada (Rabbit Lake)
	OP	Madawaska Mines, Ltd. (Bancroft)
	OP	Rio Algom, Ltd. (Quirke)
	OP	Rio Algom, Ltd. (Panel)
	UC 81	Amok, Ltd. (Cluff Lake)
	UC 83	Rio Algom, Ltd. (Stanleigh)
Gabon	OP	Comuf (Oklo, Mounana)
Namibia	OP	Rossing Uranium, Ltd. (Rossing)
Niger	OP	Cominak (Akouta)
	OP	Somair (Arlit)
Republic of South Africa	OP	Blyvooruitzicht
	OP	Buffelsfontein
	OP	Chemwes
	OP	ERGO
	OP	Harmony
	OP	Hartebeestfontein
	OP	JMS
	OP	Nuco
	OP	Palabora
	OP	Randfontein
	OP	Vaal Reefs
	OP	Western Deep Levels
	OP	West Driefontein
	OP	West Rand Consolidated
	UC 81	BEISA
	UC 83	Western Areas
	UC 83	Afrikander Lease

OP = Operating as of May, 1980.
UC__ = Mill under construction as of April 30, 1980 and production is anticipated in the year indicated.

Table 5
ESTIMATED URANIUM PRODUCTION
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1990
Australia	1.8	2.3	3.8	4.3	6.9	9.3	9.1	9.1	9.1
Canada	17.5	19.0	20.9	21.6	21.6	23.1	24.6	24.6	24.6
Republic of South Africa	12.5	15.1	18.5	19.4	20.2	20.7	21.1	21.5	21.5
Other Africa	21.8	23.7	26.8	27.8	29.6	31.6	31.6	31.6	31.6
Other Nations[3]	7.9	9.2	11.1	11.6	11.9	11.9	12.4	14.0	14.0
Non-US total (rounded to nearest million)	62	69	81	85	90	97	99	101	101
US	37	36	35	35	33	30	29	27	26
Total: World Outside Communist Areas	99	105	116	120	123	127	128	128	127

[3] Includes Argentina, Brazil, France, Mexico, Spain and others, but does not include Communist areas.

Table 6
ESTIMATED URANIUM PRODUCTION*
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1990
Operating:									
US	37.0	35.1	32.6	32.0	30.0	26.4	25.9	23.0	22.3
Non-US	61.5	69.1	76.5	78.3	80.1	82.1	82.1	83.0	82.8
Subtotal	98.5	104.2	109.1	110.3	110.1	108.5	108.0	106.0	105.1
Under Construction:									
US	—0—	0.7	2.4	2.9	3.4	3.8	3.8	3.8	3.8
Non-US	—0—	0.3	4.4	6.4	10.2	14.7	16.8	17.8	17.8
Subtotal	—0—	1.0	6.8	9.3	13.6	18.5	20.6	21.6	21.6
Total	99	105	116	120	124	127	129	128	127

*Outside Communist areas.

AFRICA

First quarter 1980 uranium production for the **Republic of South Africa** is set forth in Table 7. Total production is ten percent higher than the last quarter of 1979, and 46 percent higher than the first quarter of 1979, one year ago. South African production continues to increase as new production capacity is added. The plant expansions at Harmony are nearly complete, and the extended JMS plant is now operating at its rated capacity. Western Deep Levels will also complete a capacity expansion this year. The production figure for Vaal Reefs includes about 22,000 pounds U_3O_8 representing the initial production from Afrikander Lease. Output from the Afrikander Lease mine will continue to be treated at Vaal Reefs until the Afrikander Lease production center is completed.

Table 7
REPUBLIC OF SOUTH AFRICA
FIRST QUARTER 1980 PRODUCTION

	Thousands of Pounds U_3O_8
Blyvooruitzicht	195
Buffelsfontein	337
Chemwes (Stilfontein)	372
ERGO	170
Harmony	250
Hartebeestfontein	222
JMS	461
Palaborwa	63
Randfontein	328
Vaal Reefs	967
West Driefontein	153
West Rand Consolidated	200
Western Deep Levels	105
TOTAL	3,823

AUSTRALIA

Falling price has increased the marketing difficulties faced by Australian sellers. Their principal problem is that near-term market prices are nearing the minimum levels determined by the Australian government at a time when prices were stable and higher. At the time, the spread between market price and the government-mandated minimum levels was such that the Australian sellers had a good deal of flexibility in structuring their sales proposals, which provided incentive to buy Australian uranium. Under current market conditions, however, the spread has narrowed dramatically.

The Australian government has given no indication that it will alter its position in those commercial areas it considers important. However, it has been reported that Ranger will sign a long-term contract with a US utility this month. The terms of such a contract will have to be approved by the Australian Uranium Export Office following signature. If the contract is, in fact, signed and approved, it should provide a new benchmark for commercial terms acceptable to the Australian government.

EUROPE

The **French** government is intensifying its efforts to reduce the nation's dependence on imported oil by increasing the portion of electricity generated by nuclear power. In 1979, nuclear power produced about 16 percent of total electric power generation. The aim is to increase this figure to 50 percent by 1985. With 24 reactors now under construction, and construction to begin on ten more by the end of 1981, Electricité de France (EdF) expects to bring a new unit on line every two months. According to EdF, as of January 1980, a kilowatt-hour of nuclear generated electricity in France cost 40 percent less than coal generated electricity, and 60 percent less than oil.

In the **Federal Republic of Germany**, the utility industry association, VDEW, estimates that additional nuclear power requirements, over and above those plants already operating, will be 23,200 MWe by 1990. There are ten units currently under construction, totaling 10,900 MWe. Most of these units should be on line by 1985. Also, Kraftwerk Union was recently selected to supply the second Ohu unit (1,200 MWe) in Bavaria. However, there will still be a substantial shortfall below the VDEW target for 1990, with a corresponding drop in economic growth, if additional nuclear unit orders are not placed soon. Many in the FRG fear that the nation's lack of strong commitment to nuclear power will put German industry at a competitive disadvantage vis à vis countries—such as France—which derive their energy supplies to a greater extent from relatively more cost-effective nuclear power.

URANIUM MARKET

Final government approval has been granted for the construction of two gas-cooled nuclear plants in the **UK**. The plants are part of a British plan to order one nuclear plant per year during 1982-91. Scheduled to come on line in 1986 and 1988, the plants (1,300 MWe each) will increase Britain's nuclear power generated share of electricity from its current 13 percent to more than 20 percent.

The **Swiss** project Energie Nucléaire Kaiseraugst (ENK), the target of fierce anti-nuclear opposition, is preparing a project report for presentation to the Swiss Parliament in late 1980 which could be critical to the entire Swiss nuclear program. If parliamentary approval of the project is not given, the Swiss anti-nuclear opposition will likely be encouraged to co-operate in blocking future projects. The principal contractors for the ENK project have halted design work, pending the parliamentary ruling.

In the **USSR**, installed nuclear capacity at the end of 1979 was approximately 11,300 MWe. Of the many nuclear plants scheduled to begin operating in 1979, only four actually did. The USSR's first PWR, Novo-Voronezh unit 5, a 1,000 MWe plant which is the prototype for a series of plants, was unable to start on schedule due to sealing problems in the primary coolant pumps. In early April, the 600 MWe fast breeder reactor (FBR) at Beloyarsk delivered power —about 200 MWe—into the Russian grid for the first time. The unit is currently the largest FBR in operation in the world. The USSR plans to build several larger (1,600 MWe) units of the same type.

Elsewhere in the Eastern bloc, eight nuclear units now operating in **Bulgaria**, the **German Democratic Republic** and **Czechoslovakia** have a combined installed capacity of about 3,000 MWe.

Finland's state power company, Imatran Voima Osakeyhtio, will purchase a third unit for its Loviisa site from Techsnabexport of the USSR. The 1,000 MWe PWR is modeled after the Novo-Voronezh unit 5 in the USSR.

FAR EAST

In September 1979, Nuexco published a Special Topical Report on **Japan** entitled, *Uranium Supply and Demand in Japan*. That report presented an overview of Japan's nuclear program as a basis for understanding its uranium procurement policy. In the past six months, developments in Japan suggest that, despite technical, political, social and environmental problems, the Japanese nuclear program continues to progress.

- —Fukushima I unit 6 (1,067 MWe), owned by Tokyo Electric Power Company (Tepco), and Ohi unit 2 (1,122 MWe) owned by Kansai Electric Power Company, were successfully started up.
- —TEPCO has completed environmental evaluation of two additional 1,100 MWe units at its Kashiwazaki site and is soon expected to ask for government approval as "officially planned" projects. TEPCO is also understood to be considering plans for two additional 1,100 MWe units at a new site on the Shimokita peninsula at the northern end of Honshu.
- —Hokuriku Electric Power Company has announced plans to proceed with its initial nuclear plants—two medium-sized BWRs to be located at Noto.
- —Tohoku Electric Power Company is evaluating the feasibility of a nuclear unit for its Maki site.

All of these new plants will be operational by the late 1980's or early 1990's. Although the Japanese government has revised its official target downward to 28,000 MWe operational by 1985, Nuexco now estimates that 22,000 MWe is a more realistic figure for that year.

The Japanese have also continued to move forward in a variety of other areas, including:

- —Evaluation and planning for a large, commercial advanced thermal reactor.
- —Solution of the technical and non-proliferation problems, allowing the re-starting of the small, No. 1 reprocessing plant.
- —Establishment in March 1980 of the Japan Nuclear Fuel Service Company to own and operate the 1,200 ton/year No. 2 reprocessing plant, which is scheduled for operation in the early 1990's.
- —Organization of a new private company by four major nuclear manufacturers to proceed with detail design work on a 300 MWe fast breeder.
- —Development by Asahi Chemical, with government support, of an ion-exchange enrichment technology with a pilot plant scheduled for 1983 operation.

The range of activity, involving both the private and government sectors, is indicative of Japan's strong and continuing commitment to nuclear power.

On the uranium side, there are growing indications that the Japanese utilities are preparing for a renegotiation of the prices applicable to the 1980 and 1981 deliveries under their long-term uranium supply agreements. Although these prices, reportedly settled in the range of $44 to $46 per pound U_3O_8, were originally established by negotiation only last year, weakening market conditions have made them a growing embarrassment to the utilities.

As Phase I of its program to diversify energy sources, **Taiwan** is carrying out an ambitious expansion plan to complete 5,144 MWe of nuclear capacity, or 36 percent of the country's electric power generation capability, by 1985. The construction of coal-fired plants is also being accelerated; the current plan calls for coal, nuclear power and oil to generate about one third each of Taiwan's electricity by 1987. Table 8 shows Taiwan's nuclear power program to the year 2000.

Table 8
NUCLEAR POWER PROGRAM IN TAIWAN

	Number of Units	Size (MWe)	Incremental Installed Capacity (MWe)
Phase I (by 1985)	6	600/900	5,144
Phase II (1988-1993)	6	900	5,400
Phase III (1994-2000)	8	1,200	9,600

The **Peoples Republic of China** has renewed its interest in proceeding with nuclear power. A nuclear plant near Canton is now under consideration. Part of the output of the plant is expected to be sent to Hong Kong.

UNITED STATES

The second post-TMI limited operating license was issued to Virginia Electric and Power Co. for North Anna unit 2. A third limited operating license was issued to Public Service Electric & Gas Co. for Salem unit 2. These licenses allow loading of fuel and criticality, but not generation of electric power. Additional approvals will later be required for testing at five percent of rated power. There still have been no authorizations for power ascension since the Three Mile Island accident. Eleven US nuclear units, in addition to the three already licensed for zero power testing, are virtually complete and await only authorization by the US NRC to begin operating.

International Minerals & Chemical Corporation (IMC) has begun operation of its new commercial uranium recovery facility adjacent to its New Wales phosphoric acid plant near Mulberry, Florida. The uranium plant, the largest uranium-from-phosphate facility in the world, is currently in the start-up phase, and is progressing on schedule toward commercial operation later this month.

The plant's total uranium output could exceed two million pounds per year. This figure includes recovery of uranium processed from phosphoric acid from all of IMC's Florida plants, as well as from the nearby Bartow and Plant City phosphate operations of CF Industries. IMC has a 12-year agreement with CF Industries to extract uranium from the phosphate streams of its two plants.

Figure 1 is an aerial view of the New Wales facility, with the uranium extraction operation in the lower right quadrant.

Only one of the original 17 utility disputes with Westinghouse Electric Corp. remains in litigation, that of Long Island Lighting Co. South Carolina Electric & Gas Co. has settled with Westinghouse, but the terms of the settlement have not been announced. However, it is now possible to make a general assessment of the revised Westinghouse uranium situation. Table 9 summarizes Nuexco's estimate of the uranium involved in the utility settlements with Westinghouse. The original court-ordered allocations are included in the totals. In three of the settlements (Duquesne Lighting Co., Southern Services Co., and the Tennessee Valley Authority), there was no additional uranium involved other than the original allocations. Only the amounts involved in the original allocations are included for South Carolina Electric & Gas Co. and Long Island Lighting Co. Table 10 summarizes Nuexco's estimate of the total annual delivery obligations under the Westinghouse settlements.

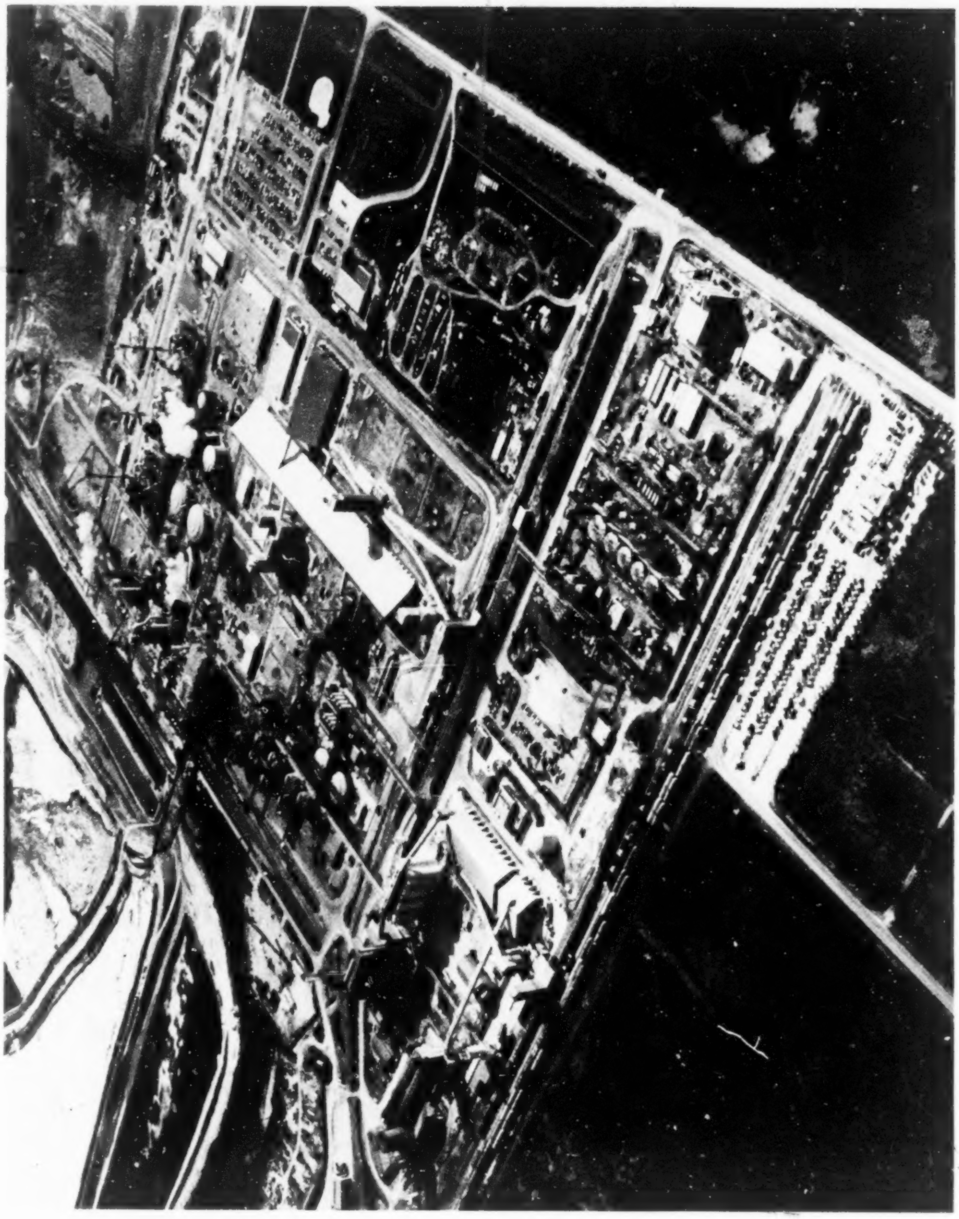


Figure 1
IMC'S NEW WALES PHOSPHORIC ACID PLANT NEAR MULBERRY, FLORIDA, SHOWING THE URANIUM RECOVERY FACILITY IN THE LOWER RIGHT QUADRANT.

URANIUM MARKET

Table 9
ESTIMATED QUANTITIES OF URANIUM INVOLVED IN WESTINGHOUSE SETTLEMENTS
(thousands of pounds U_3O_8)

Utility	Quantity Originally in Dispute[1]	Settlement Quantity[1,2]
Consolidated Edison	2,500	2,200
Duquesne (Capco)	700	100[3]
Florida Power & Light	3,600	1,700
Kansas Gas & Electric	4,000	2,400
Long Island Lighting	9,000	1,600[4]
Northeast Utilities	2,700	2,000
South Carolina Electric & Gas	4,000	800[4]
South Texas Project	10,500	8,700
Southern Services	800	100[3]
Sweden: Sydkraft SSPB OKG	5,000	3,800
Tennessee Valley Authority	3,600	600[3]
Texas Utilities	2,900	1,200
Union Electric	10,200	6,200
Virginia Electric Power	13,800	9,900
Wisconsin Electric Power	2,600	1,900
TOTAL:	75,900	43,200

---

[1] Quantities are rounded to nearest 100,000 pounds.
[2] Including original court-ordered allocation.
[3] No uranium other than original court-ordered allocation was included in settlement.
[4] Does not include South Carolina Electric & Gas Co. and Long Island Lighting Co. except to the extent of the original court-ordered allocation.

Table 10
ESTIMATED TOTAL ANNUAL DELIVERIES UNDER WESTINGHOUSE SETTLEMENTS[1]
(thousands of pounds U_3O_8)

Year	Quantity
1976	5,000
1977	2,300
1978	2,200
1979	2,300
1980	3,600
1981	1,600
1982	1,900
1983	1,100
1984	1,400
1985	1,900
1986	2,400
1987	2,400
1988	2,400
1989	2,400
1990	1,900
1991	2,000
1992	1,500
1993	1,300
1994	1,300
1995, etc.	2,300

[1] Does not include South Carolina Electric & Gas Co. and Long Island Lighting Co., except to the extent of the original court-ordered allocation.

PRICING

The **Exchange Value** decreased again this month to \$32.00 per pound U_3O_8, a drop of nine percent from the previous month.

The pace of activity in the spot market was somewhat reduced. Through most of April, there appeared to be a substantial spread, often several dollars per pound, between bids and offers. Thus, few transactions were actually concluded. However, near the end of the month, it appeared that some sellers were willing to reduce offer prices to close to bid levels in order to complete sales. This explains the large drop in Exchange Value.

Uranium available for near-term sale, as tabulated in the *Market Opportunities* section of this Report totals about 3.75 million pounds U_3O_8, down about 300,000 pounds from last month. Near-term inquiries to purchase uranium total 1.9 million pounds U_3O_8, up 900,000 pounds from last month. Most of the potential buyers for near-term delivery are producers. If prices continue to be weak, other producers have indicated that they might enter the market as buyers. That is, they might purchase material on the spot market to resell under long-term contracts, rather than produce the materials themselves.

Expressed in constant dollars, the Exchange Value has been dropping for some time. Figure 2 represents the Exchange Value expressed in constant dollars, using the Producer Price Index—Industrial Commodities, to adjust for inflation. The *real* price of uranium, expressed in today's dollars, has fallen from $60 per pound U_3O_8 in early 1976 (when the Exchange Value first reached $40) to $32, a decrease of almost a factor of two.

Price weakness is, of course, only a reflection of the basic problem—uranium production has outstripped, and continues to outstrip, consumption. As a consequence, inventories in the hands of users have continued to grow. Current inventories average two and one half to three years forward consumption. However, the utilities' perceived *need* for inventory has declined at a time when lack of timely rate relief and record interest rates have made even the maintenance of current inventory levels extremely expensive.

Inventory policy considerations should not, however, obscure the basic reason for the current price weakness; more uranium is being produced than consumed. Table 11 compares world uranium production with consumption for the years 1979 through 1983. The consumption estimates (defined as uranium entering the enrichment-fabrication pipeline for ultimate use in a reactor) in Table 11 are from Nuexco Report 140. The production estimates are from Table 6 of this Report. Annual production exceeds annual consumption by an average of more than 25 million pounds for each year in Table 11.

Thus, while it is clear that user liquidation of inventories has provided some of the impetus to the fall in uranium price over the past few months, it is only a symptom of a longer-term oversupply problem in the uranium market.

Table 11
WORLD URANIUM PRODUCTION AND CONSUMPTION
(millions of pounds U_3O_8)

Year	World Production[1]	World Consumption[1]
1979	99	69
1980	105	70
1981	116	88
1982	120	96
1983	123	104

[1] Does not include Communist areas.

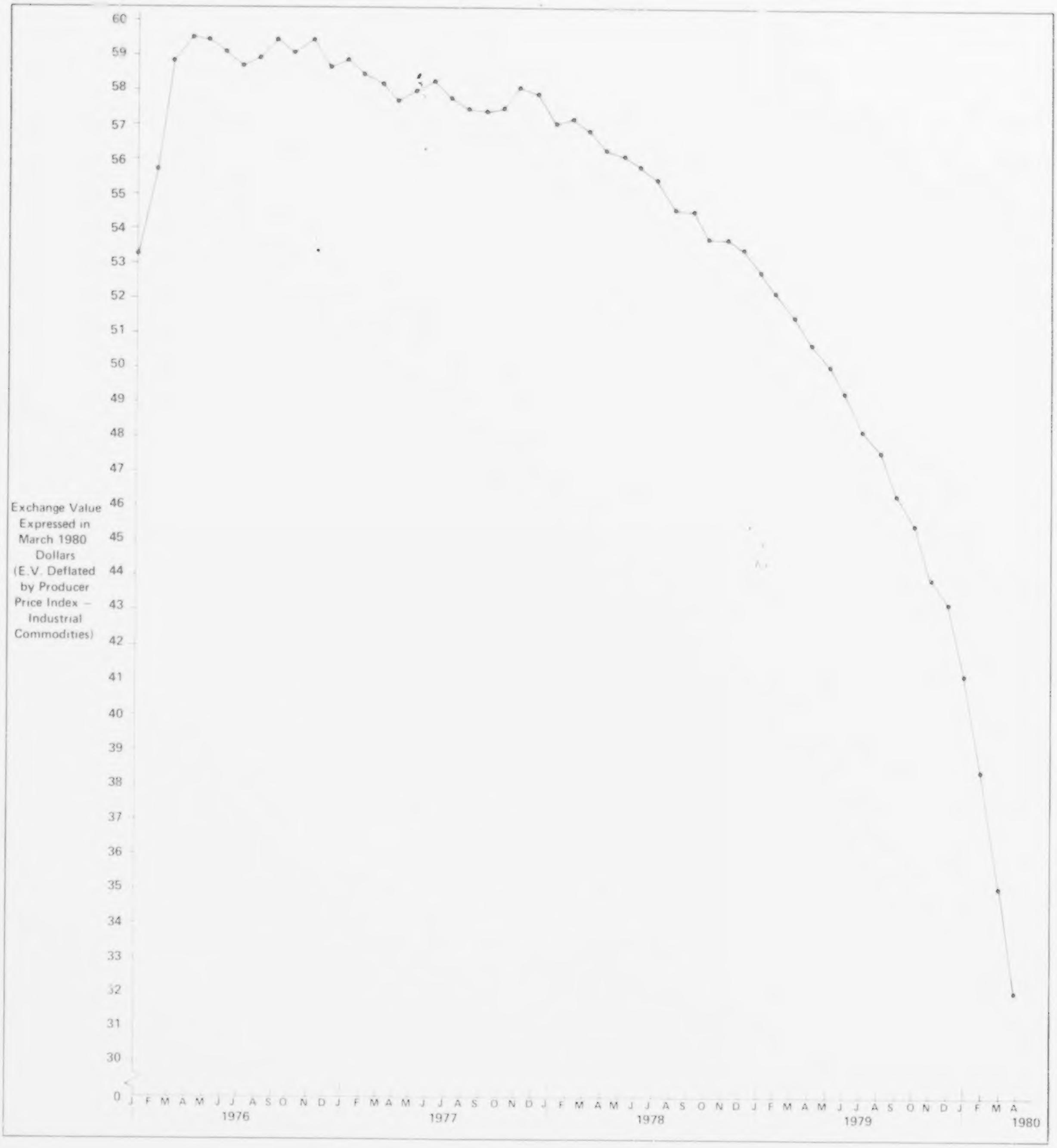


Figure 2
EXCHANGE VALUE EXPRESSED IN CONSTANT DOLLARS

COMMENTARY

NATIONAL DECISION MAKING

> *I believe that the 1980's will be a decade of decisions. The decisions will be difficult, painful, and they will require sacrifices. There are obvious problems such as energy and inflation that we must come to grips with. It is also probable that in this decade we will have to revamp the health care system in the United States and come up with alternative transportation systems for the United States.*
>
> *As I think of these issues and others, I think they have important characteristics in common. First of all, each one is vastly more complex than Three Mile Island. Second, each requires significant technical input from a variety of sources, such as scientists, engineers, medical scientists, economists, and many other sources. Third, these problems cannot be solved piecemeal, they require a systems approach. Fourth, these problems can only be solved on a national scale. Fifth, in order to implement any of these plans there will have to be a substantial national consensus to make the sacrifices acceptable. Finally, a clear decision will have to be made on the issues by the President and Congress. Currently, I do not see a process in plan to achieve these goals.*
>
> Dr. John G. Kemeny

Dr. Kemeny, President of Dartmouth College and Chairman of the Kemeny Commission on Three Mile Island spoke before the Commonwealth Club of San Francisco on March 28, 1980. His subject was a critique of national decision making. The above quotation is an excerpt from his remarks.

The thrust of Dr. Kemeny's remarks was that "our present system simply does not work, at least not with the decisions that involve science and technology" and "the only way to save it (democracy) is to make a fundamental change in the entire process of national decision making." Nuclear power was only one problem. Health care, transportation and many other technical areas are in equal difficulty.

He found in the TMI investigation that "the work of 100 well-known scientists and that of one dissenter will get equal treatment by the media;" that "emotions are having an overwhelming influence on the judgment of scientists," and "they have become advocates instead of useful advisers." He found that Congressmen made technical judgments rather than value judgments, while technical experts were asked to make value judgments rather than technical judgments.

Dr. Kemeny stressed that ours is an advanced society dependent on technology. Only a rational national decision-making process can deal with technical matters in a political environment. The fate of democracy, in Dr. Kemeny's view, may hang in the balance.

The views of such a distinguished, informed citizen should not go unheeded. But what can be done? It is obvious that two fundamental corrections have to occur:

1. Scientists must return to rendering objective judgments which do not allow for emotions to take precedence.
2. Legislators, public, bureaucracy and others must be able and willing to rely upon those technical assessments for value judgments.

Debasement of philosophical thought has been in process for years. Corruption in political thinking has not only been accepted, but often admired. Corruption has now become part of scientific thinking as judgments are warped to serve political ends.

The trend has favored an increasing reliance on the perceptual level, i.e. appealing to the senses. The unique human capabilities for conceptual thinking, i.e. integration of knowledge, and rational thinking have been subordinated. Thus we are encouraged to increase our reliance upon the level at which animals operate, and to decrease reliance upon human intellect.

Nuclear power has probably suffered most among modern technologies. Emotion dominates in the nuclear power debate. Most of the appeals we see are appeals to the senses. Rock concerts, as one example of total irrelevancy, may play as important a role as scientific argument.

An interpretation of Dr. Kemeny's message is that unless the nation can learn to cope successfully with nuclear power in our complex environment, we will not be able to solve problems in transportation, health services, and other important matters which rely upon technology. Ralph Nader and friends promised to contribute to society by converting nuclear power into a "technological Vietnam." Unless, as Dr. Kemeny says, we make a "fundamental change in the entire process of national decision-making," we may help Mr. Nader surpass his fondest hopes by producing a "democratic Armageddon."

QUARTZ-PEBBLE CONGLOMERATES—PART II

Introduction

Uranium produced from quartz-pebble conglomerates has been limited to the Witwatersrand and Elliot Lake districts. Production from each district was inspired by the large military requirements of Great Britain and the United States in the early 1950's. Mining activity created world-wide interest in quartz-pebble conglomerates. Several important discoveries have since been made, but none to equal those in either of the above districts. The details of the exploration and/or mine development in each district are reviewed in the following text.

Witwatersrand District, South Africa

The Witwatersrand sedimentary system is important to the Republic of South Africa for two reasons. It represents the world's most important source of gold, and it is the Republic's most important source of recoverable uranium, by far. The mining of gold from the conglomeratic reefs of the Witwatersrand System began about one hundred years ago. The existence of uranium was first noted in the gold ores about 1915, but it was not until 1923 that the uranium mineral was identified as uraninite. The Government Metallurgical Laboratory began an evaluation to determine the recoverability of uranium from gold ore in 1945.

Research proved that uranium could be recovered as a by-product of gold mining. A pilot system for the recovery of uranium began operating late in 1945, and successfully produced uranium concentrate for the next several years. A larger recovery system was installed in the milling circuit at the Blyvooruitzicht gold mine and mill complex near Carletonville in 1949. The first full-scale uranium mill circuit was built at Randfontein Estates in the West Rand mining district in 1952. The new industry expanded rapidly, and by 1957, there were 24 uranium recovery plants operating, with a total annual production of more than 10 million pounds U_3O_8.

The advent of commercial nuclear power in the mid-1960's created new interest in uranium, and production began to increase again. Several new recovery plants were constructed to meet the demand. However, by 1975 the price of gold had increased, leading to the mining of lower-grade ores, with an accompanying decrease in uranium production (gold and uranium content of ore are compatible and tend to vary in about the same ratio—see Part I of this article, Nuexco Report 140, for discussion of the genesis of the ore deposits contained in the Witwatersrand conglomerate). The same situation exists today as a result of increasing gold prices.

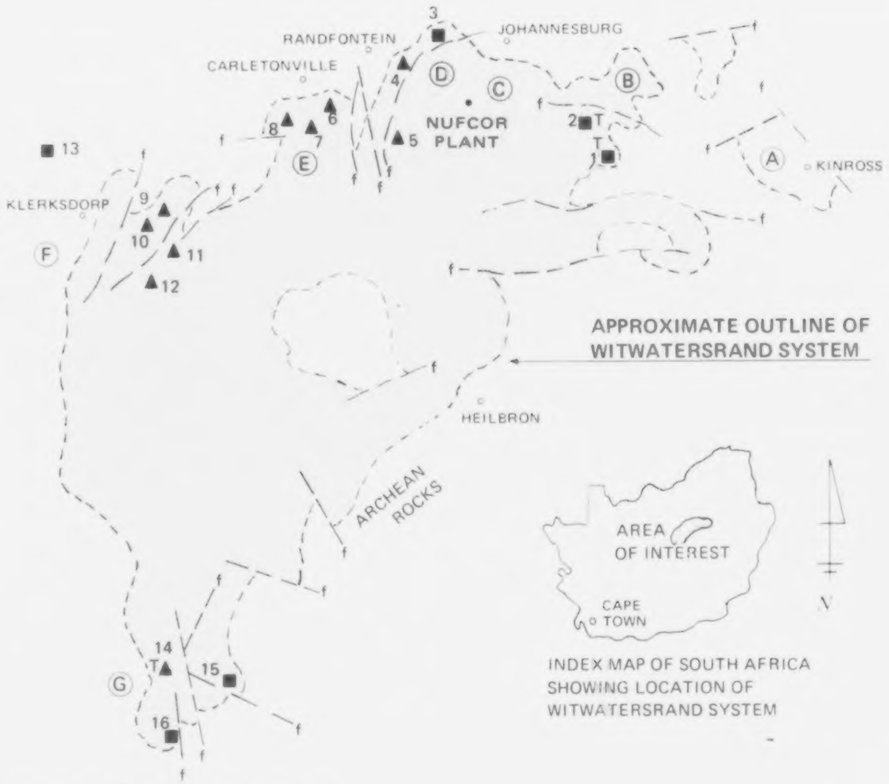
Uranium production has gradually increased since 1975. There are presently ten mines recovering uranium as a by-product of gold mining and one such recovery facility is under construction. Uranium is recovered as the primary mineral in four additional operations, with two others under construction. Two of the primary uranium producers are reworking old mill tailings to recover uranium along with gold. One mine in South Africa recovers uranium as a by-product of copper mining. Uranium production totaled 12.5 million pounds U_3O_8 in 1979. It is expected to total about 15.1 million pounds in 1980. Figure 3 is a map of the Witwatersrand district showing the location of the various mining areas and the current uranium recovery operation.

Economically recoverable amounts of uranium and/or gold have primarily been mined from a number of conglomeratic reefs in the upper 8,500 feet of the Lower Witwatersrand division and the basal 5,400 feet of the Upper Witwatersrand division. The combined thickness of the entire metasedimentary series is estimated to be approximately 25,000 feet toward the center of the synclinal basin. Most of the mines are located along the northern rim and southern tip of the basin, where mining depths vary from less than 2,000 feet to more than 12,000 feet.

The lower division of the Witwatersrand System consists of alternating shales, quartzites and quartz-pebble conglomerates. The basal unit is the Hospital Hill Series, which contains few, if any, conglomerates and no known economically recoverable occurrences of uranium or gold.

The Government Reef Series, which overlies the Hospital Hill Series, is about 6,500 feet thick and contains at least three mineralized reefs. The Promise and Bonanza Reefs are a source of gold only in the Central Rand and Klerksdorp districts, respectively. The Red Bluff Reef is near the top of the Government series, and is mined for uranium with gold produced as a by-product, in the Klerksdorp district.

The upper portion of the Lower Witwatersrand division is the Jeppestown Series consisting of almost 3,700 feet of conglomerates, shales and quartz-


3
RANDFONTEIN
JOHANNESBURG
CARLETONVILLE
4
Ⓓ
Ⓒ
Ⓑ
6
8
7
5
NUFCOR PLANT
2 T
T
1
13
Ⓔ
Ⓐ
KINROSS
KLERKSDORP
9
10
11
12
Ⓕ
f
APPROXIMATE OUTLINE OF WITWATERSRAND SYSTEM
HEILBRON
ARCHEAN ROCKS
AREA OF INTEREST
CAPE TOWN
N
INDEX MAP OF SOUTH AFRICA SHOWING LOCATION OF WITWATERSRAND SYSTEM
14
T
15
Ⓖ
16

Approximate Scale: one inch = 30 miles

EXPLANATION

MINING DISTRICT

Ⓐ – EVANDER
Ⓑ – EAST RAND
Ⓒ – CENTRAL RAND
Ⓓ – WEST RAND
Ⓔ – FAR WEST RAND
Ⓕ – KLERKSDORP
Ⓖ – FREE STATE

URANIUM PRODUCTION

■ – PRIMARY MINERAL PRODUCED
▲ – BY-PRODUCT OF GOLD
T – RECOVERY FROM TAILINGS

SYMBOLS

f – FAULT
○ – CITY

PRODUCTION CENTER INDEX

1. NUCO*
2. ERGO*
3. WEST RAND CONSOLIDATED*
4. RANDFONTEIN/COOKE SECTION
5. WESTERN AREAS (under construction)
6. WEST DRIEFONTEIN
7. WESTERN DEEP LEVELS
8. BLYVOORUITZICHT
9. CHEMWES (STILFONTEIN)
10. HARTEBEESTFONTEIN
11. BUFFELSFONTEIN
12. VAAL REEFS
13. AFRIKANDER LEASE* (under construction)
14. JOINT METALLURGICAL SCHEME
15. HARMONY*
16. BEISA* (under construction)

*Uranium is primary mineral produced.

Figure 3
WITWATERSRAND URANIUM/GOLD DISTRICT, SOUTH AFRICA

ites. No mining is carried out in the Jeppestown. However, the upper 200 feet of the series represent the depositional transition zone between the Lower and Upper Witwatersrand divisions. Erosional lows within the series are known to be filled with minable reefs which are correlated to the Upper division.

In the Klerksdorp district, mining has progressed into the Dominion Reef, which is below the Lower division of Witwatersrand. The Dominion Reef is the oldest sedimentary series in the basin and is in unconformable contact with highly-eroded Archaen rocks. The Dominion Reef System consists of about 9,000 feet of volcanics, quartzites and conglomerate reefs, at least two of which contain economically recoverable values of both uranium and gold. In a highly-faulted portion of the Klerksdorp district, the Witwatersrand System is in contact with the Dominion Reef. In this area, the Upper and Lower portion of the Dominion Reef System are mined for uranium. Gold is produced as a by-product. The two reefs are also mined for uranium on the Afrikander Lease.

The lower 3,300 feet of the Upper Witwatersrand division are commonly referred to as the Main-Bird Series and are of major importance for gold. The lower 700 feet of the series are comprised of the Main Reef Group, which contains four subordinate reefs. The Carbon Leader is the only uranium-bearing reef in the group. It is mined in the West and Far West Rand districts for gold and by-product uranium. Three other reefs, the North Reef, the Main Reef Leader and the South Reef, in ascending order, are important for gold content, but not uranium, in the Far West, West, Central and East Rand districts.

The Bird Reef Group of the Main-Bird Series is approximately 2,700 feet thick and contains four important uranium and gold-bearing reefs in the lower portion. The lowest is the Bird Reef, from which uranium is produced as the primary mineral in the West Rand district, with gold as a by-product. The next three reefs occurring in the ascending sequence are mined for gold, with uranium recovered as a by-product. They consist of the Basal Reef in the Orange Free State district, and the Leader Reef and the Vaal Reefs in the Klerksdorp district.

The uppermost 6,200 feet of the Upper division include the Kimberley-Elsburg Series which contains six ore-bearing reefs in the Kimberley Group and three in the Elsburg Group. The lowest reef in the Kimberley Reef Group is the Kimberly-B Reef. It is mined for uranium, with gold produced as a secondary mineral, in the Orange Free State district. Gold is the only mineral of importance in the Kimberly Reef and the Kimberley-A Reef, both in the Evander district. Gold and by-product uranium are recovered from the Kimberley Reef in the East Rand district. Only gold is recovered from the two upper reefs —the K9 Reef in the Central Rand district and the Battery Reef in the West Rand district.

The important reef in the Elsburg Group is the Middle Elsburg Reef in the West Rand district, which is mined primarily for uranium. Gold is mined from Individuals Reef in the Klerksdorp and Orange Free State districts. The uppermost reef in the group is the Massives, which is a gold-bearing reef in the West Rand district.

The Ventersdorp System overlies the Witwatersrand System. It consists of massive volcanic flows, quartzites and scattered quartz-pebble conglomerates. A thin layer of conglomerate occurs at the contact between the Witwatersrand System and the volcanic rocks of the Ventersdorp System. This reef is referred to as the Ventersdorp Contact Reef. It is an important source of gold in the West Rand, Far West Rand and Klerksdorp districts.

Generally, important reef series are correlated from district to district. However, reef groups are commonly found throughout neighboring districts, but not necessarily throughout the basin. The inconsistencies are attributable to a break-up in depositional patterns due to erosional surface features and the distance from the materials source area. Later metamorphism and structural development of the basin caused disruptions in continuity, especially in areas of major faulting, as in the Klerksdorp district. Controversy over correlation among the various reefs will persist as long as mining is carried out.

Elliot Lake District, Ontario, Canada

Uranium was first discovered in quartz-pebble conglomerates of the Huronian Formation near the northern shore of Lake Huron in 1948. A prospecting rush ensued and the outcrop area of the lower conglomeratic sequence of Huronian rocks was evaluated from Sault St. Marie eastward to Sudbury and northward to Quirke Lake. Many radiometric anomalies were located, but in almost every case, the percentage of U_3O_8 contained in the surface rock was too low to be mined. The first commercial-grade uranium was discovered during a test drilling program down-dip from a surface anomaly near the town of Blind River in 1952.

The discovery became known as the Pronto ore deposit. Another round of exploration activity followed. Five separate mineralized zones were discovered within the Huronian conglomeratic sequence. Of the five zones, the Quirke Lake and Nordic ore zones with ore values of one to four pounds U_3O_8 per ton, represent two of the largest uranium deposits known to occur in quartz-pebble conglomerates. The remaining three ore zones—the Whiskey, Pecors and Pardee contain lower grades, and have not yet been developed. Figure 4 shows the five ore zones and the location of mines and mills within the district.

The first ore deposit to be developed was the Pronto, which began production in early 1955. Less than four years later, 12 deep-shaft mines and 11 processing mills were operating on the Quirke and Nordic ore zones, at a production capacity of about 40,000 tons of ore per day. Elliot Lake had become the most important uranium district in Canada within ten years after uranium mineralization was first discovered.

The Huronian metasedimentary sequence is 10,000 feet thick, consisting of quartzites, argillites and arkose sand units interbedded with fine to coarse-grained conglomeratic beds. Uranium mineralization is confined to the conglomerate reefs in the basal Matinenda formation which is in unconformable contact with older crystalline rocks of Archean age. The depositional characteristics of the Elliot Lake reefs closely parallel those of the Witwatersrand Sequence. The most important difference is a lack of commercial amounts of gold in Elliot Lake deposits.

Huronian rocks have been folded to form an east-west trending syncline in the Elliot Lake district. The lower Matinenda conglomerates outcrop on both limbs of the syncline. It was along the outcrop area that anomalous radioactivity was first encountered, eventually leading to the five discoveries. The Quirke ore zone on the northern flank of the syncline is the largest ore deposit in the district. The deposit parallels the synclinal trend for about 35,000 feet, at widths varying from 6,000 to 10,000 feet. Minable ore depths vary from about 1,000 feet along the northern limits to over 3,500 feet in the south. The Nordic ore zone, which is located on the southern limb of the syncline, was the site of the first mine development in the area—the Buckles mine began ore production in late 1955. The Nordic zone extends northwest from the outcrop for about 20,000 feet, and has an average width of 5,300 feet. Depth to the ore zone averages about 1,500 feet. Ore thickness varies from 8-20 feet in the two ore zones.

Denison Mines Ltd. and Rio Algom Ltd. have produced uranium in the district since 1957. Denison controls a large portion of the Quirke ore zone, where all its activities are located. Production from the Denison mine has increased to about 9,500 tons per day from 5,000 tons per day in 1975. Denison has established a production goal of 21,000 tons per day for 1985. It has scheduled the rehabilitation of the Stanrock and Can-Met mining areas to attain the 1985 production goal. The processing mill located at the Denison mine is scheduled to be expanded to handle 15,000 tons of ore per day, up from the current rate of 7,100 tons per day. Total U_3O_8 production was about 4.5 million pounds during 1979. The expansion program was initiated by Denison in connection with a long-term sales contract with Ontario Hydro.

Rio Algom Ltd. controls the Quirke, New Quirke, Panel and Spanish American mines located on the Quirke ore zone. Mine production during 1979 was 7,000 tons ore per day; total U_3O_8 production in 1979 was 4.9 million pounds from the Quirke mine and mill complex. The Panel mine and mill were reopened in 1979 as part of Rio's expansion program. It contributed an additional 2,400 tons ore per day, and 390,000 pounds U_3O_8, bringing total Rio Algom 1979 production to 5.3 million pounds U_3O_8. Full production of 3,000 tons per day at the Panel mine is expected to be achived during 1981. In addition, Rio Algom has started renovation of the Stanleigh mine and mill located on the Nordic ore zone, in connection with a long-term agreement with Ontario Hydro. The mine is scheduled to produce at the rate of about 5,000 tons ore per day by 1983. Rio Algom is currently considering a plan to reopen the Milliken mine. It is also probable that the Lacnor and Nordic mine workings will be dewatered and the ore mined through the Milliken.

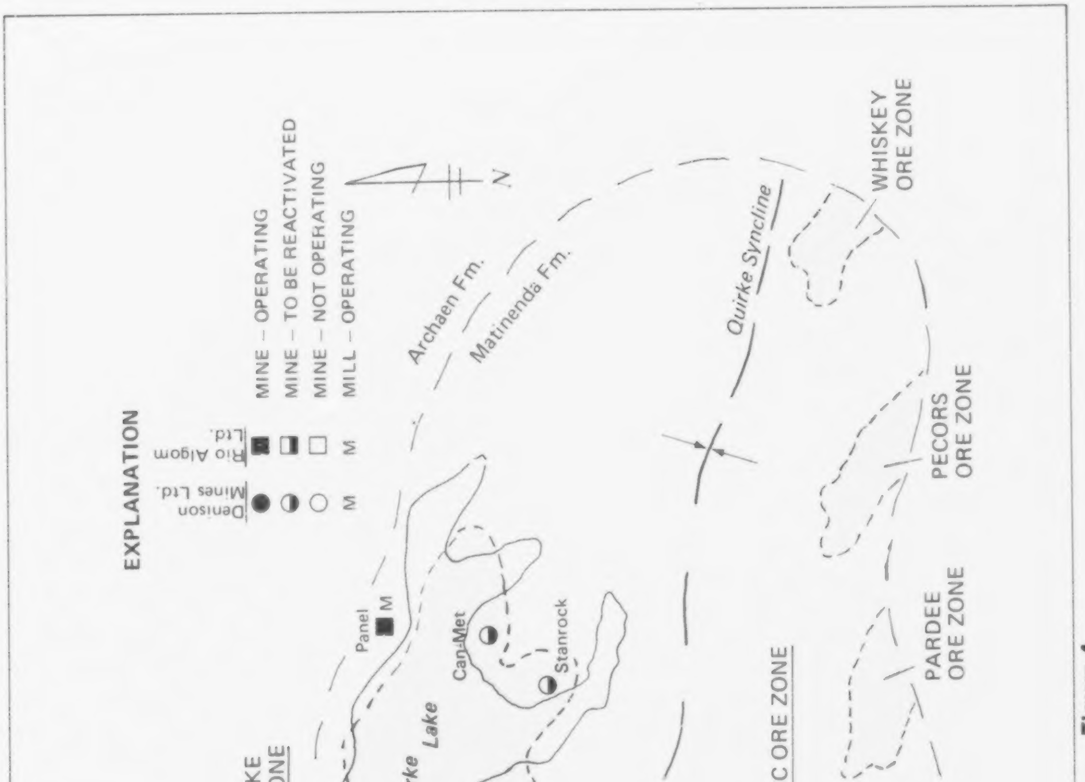

EXPLANATION
Denison Mines Ltd.
Rio Algom Ltd.
● ■ MINE – OPERATING
◐ ◧ MINE – TO BE REACTIVATED
○ ☐ MINE – NOT OPERATING
M M MILL – OPERATING
N
Archaen Fm.
Matinenda Fm.
Quirke Syncline
WHISKEY ORE ZONE
PECORS ORE ZONE
PARDEE ORE ZONE
NORDIC ORE ZONE
QUIRKE ORE ZONE
APPROXIMATE SURFACE OUTCROP OF HURONIAN CONGLOMERATIC SEQUENCE
Panel M
Can-Met
Stanrock
Quirke Lake
Quirke M
New Quirke
Denison M
Spanish American
Stanleigh
Milliken
Lacnor
Nordic
Buckles (1st mine in area)
Elliot Lake
Approximate Scale: one inch = two miles

Figure 4
ELLIOT LAKE URANIUM DISTRICT
ONTARIO, CANADA

World Districts

Exploration activity for uranium in Early Proterozoic metasediments has been concentrated on quartz-pebble conglomerates because of depositional and mineralogic similarities to the Elliot Lake and Witwatersrand districts. Evaluation techniques used in prospective areas are modeled after the successful techniques applied at Elliot Lake and in the Witwatersrand. Several areas have been evaluated, but with limited success.

One of the most promising prospects at this time is in the vicinity of Jacobina, Bahia, in **Brazil**, where quartz-pebble congomerates occur on the periphery of a syncline within the limits of the São Francisco Archean complex. The area has been known as a gold district since the 17th century. Uranium has been associated with gold in the conglomeratic lenses or reefs, in the Serra do Corrego Formation of the Jacobina Series. Uraninite and gold mineralization is concentrated in the fine segment of the reef matrix. The reefs tend to be discontinuous throughout the strike-length of the outcrop area. They vary in thickness from a trace to about four feet, interbedded with quartzite. The formation is about 6,000 feet thick, with most reefs occurring well up in the section. The Piritoso and the Chahu reefs are the main gold and uranium-bearing reefs in the district. Uranium values average between 0.02% to 0.04% U_3O_8. Uranium is secondary in content to gold. Uranium resources in the district are not known.

Uranium and gold-bearing conglomerates occur in two other areas of the same district. Reefs form the basal part of the Moeda Formation of the Minas Series and Nova Lima Group of the Rio das Velhas Series in the vicinity of Belo Horizonte. In each case, the percentage of uranium present is too low for mining. Considerable exploration remains to be completed in each area.

Early Proterozoic conglomerates of interest in the **United States** are limited to the southern Lake Superior region and the Wyoming Province. The areas of interest in the Lake Superior region offer only limited potential for the occurrence of uranium in quartz-pebble conglomerates, due to the age correlation of the metasediments. The potential conglomerates occur with other sediments as fill in synclines upon an Archean surface. The oldest conglomerates in the district have been estimated to be 1,400 to 2,100 million years old, which is at least 200 to 400 million years younger than the youngest uraniferous reefs at Elliot Lake and Witwatersrand. The greatest potential is for gold. However, an unknown number of uranium "shows" have been discovered in the past.

The area of interest in the Wyoming Province consists of an eight-mile-thick section of highly contorted rocks within the Medicine Bow Mountains. The metasedimentary rock section is considered to be 1,700 to 2,500 million years and is subdivided into three ascending age groups—the Phantom Lake Metamorphic Suite, Deep Lake Group and the Libby Creek Group. The Phantom Lake Group is separated into lower and upper sections by an obvious unconformity. The unconformable surface is overlain by a uraniferous quartz-pebble conglomerate.

The Deer Lake Group is, in turn, subdivided into six formations. The Magnolia Formation makes up the basal unit. It contains a series of interbedded conglomerates, most of which are radioactive. The potential of the Magnolia Formation is secondary to the Phantom Lake Suite which, according to sample assays, contains up to 140 parts per million uranium on the outcrop. Formation characteristics are similar to those of known uranium-bearing reefs. Additional exploration of the formation is justified on this basis.

Radioactive quartz-pebble conglomerates and related metasediments are known to exist in the Sierra Madre Mountains of southcentral Wyoming and in the Hartville uplift near Lusk, Wyoming. The Black Hills uplift of South Dakota consists of a series of metasediments and metavolcanics containing radioactive segments. One segment, the Estes quartz-pebble conglomerate is radioactive, and has been age-dated at about 2,500 million years. It is considered to be a favorable exploration target for both uranium and gold.

Uraniferous metasediments of Early Proterozoic Age are known to occur in a number of other locations. Usually the basal unit, which is in unconformable contact with Archean rocks, is a quartz-pebble conglomerate with characteristics analogous to those in the Witwatersrand and Huronian depositional sequence. In Central Africa, uranium occurs in basal conglomerates which are in fault contact with Archean granite near Mounana, **Gabon**, and in the Kawere Conglomerate of the Tarkwa Sequence in

Ghana and the **Ivory Coast**. In **India**, the basal conglomerates of the Dharwar Sequence are of interest for both gold and uranium mineralization in the Precambrian shield areas of Karnataka, Singhbhum, and Aravalli. The Karelian Sequence (metasedimentary) in the **USSR** forms a potential mineral belt which extends northwest through **Finland** and **Sweden**. Uranium occurrences are known to occur along the trend of highly faulted and contorted rocks. Early Proterozoic metasediments crop out on the periphery of the Angara shield in Siberia. There are no reported occurrences of uraniferous conglomerates in the series, but the formation characteristics fit the Witwatersrand model. The potential of the area is favorable.

The Precambrian provinces of **Australia** fall into the same favorable category, due to rock characteristics and the wide distribution of uranium found in Middle Proterozoic rocks in the Northern Territory. Favorable exploration targets exist in the Fortesque Series of the Hamersley Basin, the Malmac Formation along the north edge of the Nabberu Basin, and the King Leopold Conglomerate in the Halls Creek district, all in Western Australia. The potential for Early Proterozoic uranium in the Pine Creek Geosyncline is greatly limited because the rocks are of marine origin rather than fluvial as at Witwatersrand and Elliot Lake.

STATISTICAL DATA

EXCHANGE VALUE—\$32.00/lb U_3O_8
Determined as of April 30, 1980

DEFINITION

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

COMMENTS

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of April 30, 1980

\$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
38.40	3.6	13	3

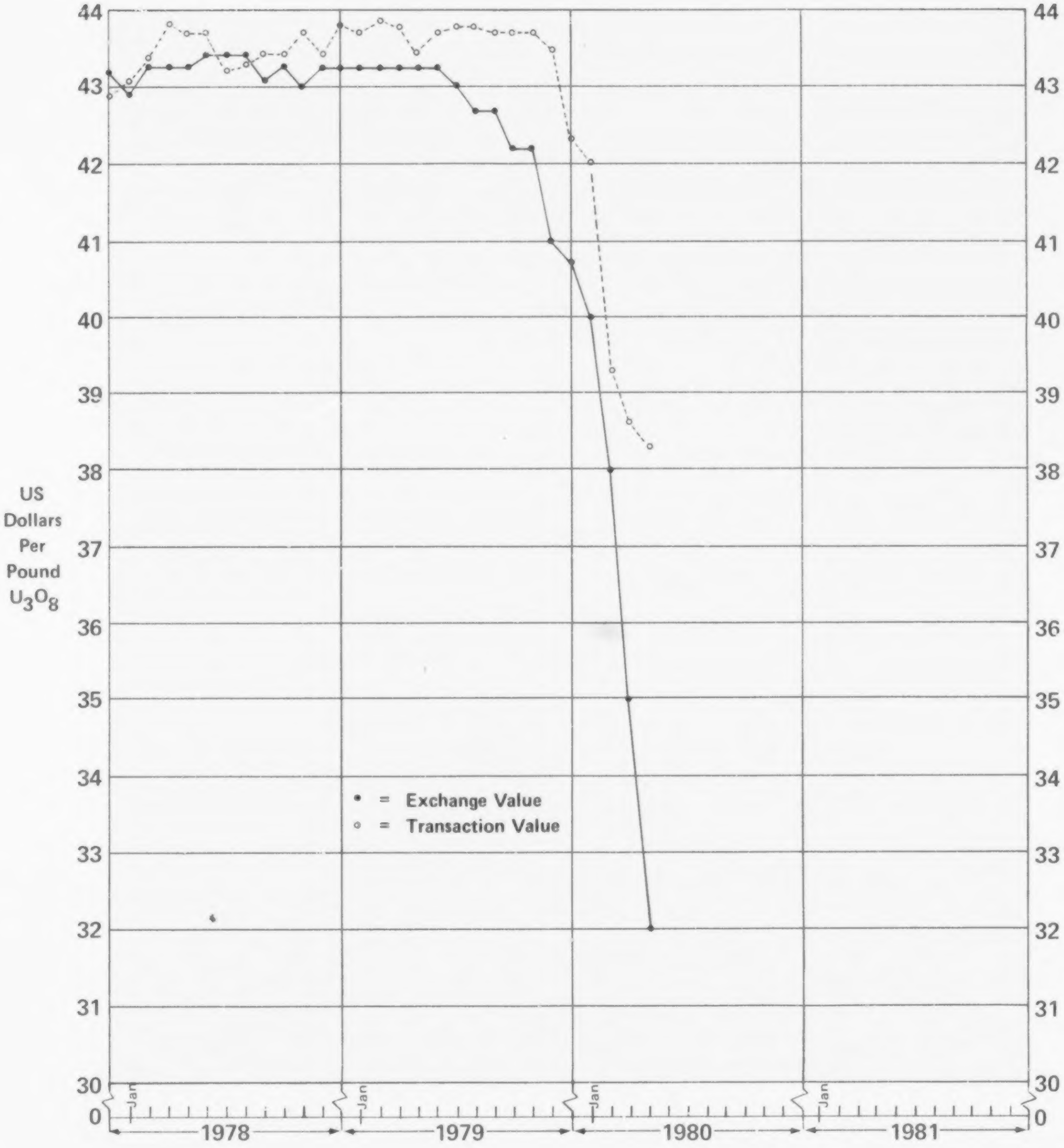
DEFINITION

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES

Determined as of the last day of the month indicated



STATISTICAL DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated

(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00								

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated

(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40								

Note: See Nuexco Report 135 for a discussion of the definition of Transaction Value.

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	32.00	70.55	83.19
France (franc)	135.48	296.68	352.21
FRG (mark)	58.03	127.94	150.88
Japan (yen)	7,804	17,206	20,290
Switzerland (franc)	54.24	119.57	141.00
UK (pound)	14.13	31.15	36.73
Australia (dollar)	28.87	63.64	75.05
Canada (dollar)	37.83	83.41	98.36
Niger, Gabon (CFA)	6,774	14,934	17,611
South Africa (rand)	25.76	56.97	66.97

*Calculated using currency exchange rates published in the Wall Street Journal on the last Friday of the month

LOAN USE CHARGE RATE — 7.0%/year

DEFINITION

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Nuexco Reference Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as percent of Current E.V.	Seller Group	Buyer Group	Remarks
1099	80	Less than 50	114	US	Far East	UF_6
1105	80	300 to 600	—	US	Europe	Definitive price information not available
1110	80	100 to 300	101	US	US	

---

* Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

STATISTICAL DATA

OPTIMUM TAILS ASSAY

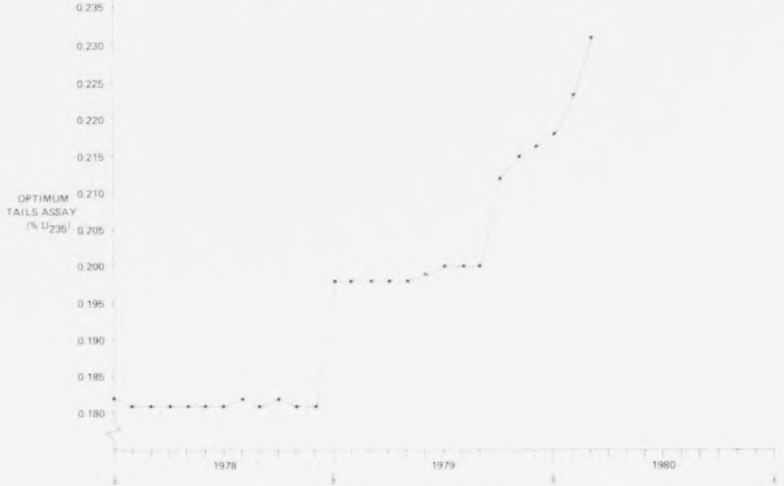
The optimum tails assay is the tails composition at which the cost of enriched uranium is lowest for given costs of separative work (SWU) and natural uranium feed. It depends only on the ratio of the cost of a kilogram of natural uranium in the form of UF_6 to the cost of a kilogram unit of separative work. The US Department of Energy (USDOE) Adjusted Fixed Commitment (AFC) enrichment contract holders have the option, within limits, to specify the transaction tails assay. The transaction tails assay for USDOE Requirements contracts is 0.20 percent U_{235}. For every one-hundredth of one percent increase in the transaction tails assay, uranium consumption increases about two percent.

TAILS ASSAY FOR MINIMUM COST OF PRODUCT*

Ratio of Unit Cost of Feed to Unit Cost of SWU

*From Nuexco Report 138

HISTORICAL OPTIMUM TAILS ASSAY†



†Based on Exchange Value and USDOE AFC SWU price, interpolated to the nearest thousandth

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 100)[1]	Consumer Price Index (1967 = 100)[2]	GNP Implicit Price Deflator (1972 = 100)[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]		
				Metal Mining (SIC 10)	**Primary Non-ferrous Metals (SIC 333)**	**Chemicals and Allied Products (SIC 28)**
Annual Avg. 1970[5]	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971[5]	114.0	121.3	96.02	4.12	4.15	3.94
Annual Avg. 1972[5]	117.9	125.3	100.00	4.49	4.59	4.21
Annual Avg. 1973[5]	125.9	133.1	105.80	4.82	4.98	4.48
Annual Avg. 1974[5]	153.8	147.7	116.02	5.43	5.63	4.85
Annual Avg. 1975[5]	171.5	161.2	127.15	6.13	6.24	5.37
Annual Avg. 1976[5]	182.3	170.5	133.71	6.75	6.87	5.89
Annual Avg. 1977[5]	195.1[4]	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978[5]	209.4	195.4	152.05	8.23	8.56	7.01
Annual Avg. 1979[5]	236.3P	217.4	165.46	9.27	9.50	7.59
Jan 1979	220.0	204.7	—	8.71	9.01	7.32
Feb 1979	222.5	207.1	—	8.81	9.02	7.32
Mar 1979	225.4	209.1	160.22	8.84	9.11	7.36
Apr 1979	229.0	211.5	—	9.03	9.49	7.50
May 1979	231.6	214.1	—	9.06	9.15	7.47
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9	—	9.32	9.57	7.60
Aug 1979	240.6	221.1	—	9.38	9.70	7.65
Sep 1979	244.2	223.4	167.20	9.63	9.79	7.73
Oct 1979	248.5	225.4	—	9.67	9.87	7.82
Nov 1979	250.2	227.5	—	9.79	9.86	7.87
Dec 1979	252.8	229.9	170.58	9.80R	9.92	7.91
Jan 1980	260.3	233.2	—	9.92	10.06	7.96
Feb 1980	265.4	236.4	—	9.91P	10.02P	7.99P
Mar 1980	268.2	239.8	—	—	—	8.05P

P = Preliminary R = Revised since last month

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. All data for 1977 and beyond are adjusted to the most recent benchmark—March 1978—and are subject to revision from that point foward with the advent to the next benchmark scheduled for publication in late 1980.

(5) Data for these years, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Nuexco Report 139.

STATISTICAL DATA

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry – All Groups (Year 1968-69 = 100.0) (1)	Weighted Average Minimum Weekly Wage Rates – Adult Males Australia Mining and Quarrying (A$) (2)
Annual Avg. 1970 (3)	101.4	59.88
Annual Avg. 1971 (3)	101.5	65.95
Annual Avg. 1972 (3)	105.6	71.26
Annual Avg. 1973 (3)	124.4	78.96
Annual Avg. 1974 (3)	141.9	108.07
Annual Avg. 1975 (3)	150.4	132.55
Annual Avg. 1976 (3)	168.4	160.93
Annual Avg. 1977 (3)	192.0	179.03
Annual Avg. 1978 (3)	215.4	190.04
Nov 1978	232.2	190.86
Dec 1978	235.7	199.28R
Jan 1979	246.3	199.79R
Feb 1979	253.0	200.00
Mar 1979	264.0	201.45R
Apr 1979	273.0	202.27
May 1979	287.5	203.38R
Jun 1979	293.8	209.88R
Jul 1979	295.8	210.49R
Aug 1979	290.8	211.56
Sep 1979	300.0	212.34R
Oct 1979	307.0	211.80R
Nov 1979	308.0P	211.12
Dec 1979	317.0P	212.73P

P = Preliminary   R = Revised since last month

(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

(2) Australian Bureau of Statistics, Canberra; "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest twelve months shown are subject to revision.

(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Nuexco Report 138.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000) (1), (2) (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings ($C) (3), (4)		
		Metal Mining, including milling (SIC 050-059)	**Primary Metal Industries, non-ferrous (SIC 296-298)**	**Chemicals and Chemical Products (SIC 370-379)**
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Annual Avg. 1979	217.8	—	—	—
Dec 1978	199.4	9.29	6.93	7.14
Jan 1979	204.8	9.19	7.14	7.29
Feb 1979	208.5	9.24	7.18	7.36
Mar 1979	210.4	9.47	7.20	7.51
Apr 1979	212.8	9.68	7.26	7.63
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3	9.37	7.34	7.73
Aug 1979	220.0	9.56	7.38	7.77
Sep 1979	223.4	9.75	7.50	7.81
Oct 1979	227.4	9.89R	7.54	7.88
Nov 1979	228.1	9.97	7.61	7.91
Dec 1979	230.2R	9.93	7.51	7.89
Jan 1980	238.4	9.96P	7.62P	8.00P
Feb 1980	240.1P	—	—	—

P = Preliminary R = Revised since last month

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 4.10 of Nuexco Report 138.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 4.11 of Nuexco Report 138.

STATISTICAL DATA

REPUBLIC OF SOUTH AFRICA STATISTICS

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)(1)	Consumer Price Index(2) (1975 = 100, except where otherwise indicated)
Annual Avg. 1970(3)	7.34	100.3(4)
Annual Avg. 1971(3)	7.88	106.4(4)
Annual Avg. 1972(3)	8.79	113.3(4)
Annual Avg. 1973(3)	10.51	124.1(4)
Annual Avg. 1974(3)	13.18	138.5(4)
Annual Avg. 1975(3)	16.71	157.2(4)
Annual Avg. 1976(3)	19.30	174.7(4)
Annual Avg. 1977(3)	23.87	194.4(4)
Annual Avg. 1978(3)	27.14	137.2
Annual Avg. 1979(3)	30.18	155.3
Jan 1979	–	145.3
Feb 1979	–	146.1
Mar 1979	28.60	148.6
Apr 1979	–	149.9
May 1979	–	150.6
Jun 1979	29.44	152.4
Jul 1979	–	157.9
Aug 1979	–	160.2
Sep 1979	30.71	162.1
Oct 1979	–	162.9
Nov 1979	–	163.4
Dec 1979	31.89	164.0
Jan 1980	–	165.4
Feb 1980	–	167.0
Mar 1980	–	168.0

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(1) Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly.

(2) Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Price Index for Urban Areas."

(3) Historical data for 1970 through 1979 appear on page 4.9 of Nuexco Report 140.

(4) April 1970 = 100.00

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

SUPPLY

Nuexco Reference Number	**Delivery Period (Thousands of Pounds U_3O_8)**				**Remarks**
	1980	**1981**	**1982**	**1983**	
Uranium Available for Sale:					
1213	700				
1236	100	100	100		
1274	150				
1284	250				
1286	350	150	150	150	
1306		100	200	200	
1315			200	200	
1324		500	500	500	
1325	750				
1333	350	250	250		
1338	250				
1346	100				
1377	50				
1392	300				
1394	250				
1403	150				
TOTALS	3750	1100	1400	1050	
Uranium Available for Loan:					
1136	1000				UF_6
1136A	350				
1175	700				UF_6
1234	700				
1354	600				UF_6
1355	600				
1383	1000				
TOTAL	4950				

MARKET OPPORTUNITIES

DEMAND

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8)				Remarks
	1980	1981	1982	1983	
Inquiries to Purchase:					
1146		100	200	200	
1321			400	400	
1335	200				
1357		300			
1380	900				
1381	150				
1396	200				
1406	50				
1408	150				UF_6
1410		2000	2000	2000	
1412	250				
TOTALS	1900	2400	2600	2600	
Inquiries to Borrow:					
1220	1000				
1260	600				
1348	350				
1404	300				
TOTAL	2250				

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NUEXCO

JUNE 1980 **NUMBER 142**

Monthly Report on the Uranium Market

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT 142

The **Exchange Value** remained at $32.00 per pound U_3O_8 for the month, stabilizing partly due to the return of lower interest rates and more plentiful loan money; as a consequence, some US utilities have reduced their efforts to sell uranium in inventory. Many potential buyers in the market continue to be producers, but it is significant that utilities are beginning to reappear as buyers. Some potential buyers believe the market has reached the bottom of its present decline, and hope to acquire material at attractive prices. The **Transaction Value** decreased to $37.90 per pound U_3O_8, from $38.40 the previous month.

The **General** section of this Report updates the supply demand balance analyzed earlier in Report 135. It is based on Nuexco estimates of apparent future consumption (Report 140) and future firm supply of uranium (Report 141). Delays and cancellations of reactor projects are combining with the apparently ample future availability of uranium to form an increasingly competitive market. High cost producers are likely to phase down operations, as low cost producers phase up. Although expanded production from Australia and western Canada is no longer *essential*, both countries will play a major role in the future market, due to their lower costs of production.

Spot market activity last month included four transactions involving US and Canadian sellers, and European and Far Eastern buyers.

The **British** Civil Uranium Procurement Organization has decided to not participate in the equity financing of Energy Resources of **Australia**. As with the prospective investors from **Japan** and the **FRG**, the British see less advantage in holding an equity position to ensure long-term security of supply during a period of weakening price, declining demand and perceived oversupply.

Australia's intent to develop enrichment capability received a boost when the **US** Department of Energy (USDOE) indicated interest in participating in a multi-national enrichment facility based in Australia.

The **People's Republic of China** has rekindled its interest in nuclear power. Plans for a 900 MWe unit near Canton are progressing; China Power & Light of **Hong Kong** will finance 40 percent of the plant's estimated cost and purchase 40 percent of its power.

USDOE's estimate of **US** uranium reserves as of January 1, 1980, increased slightly over last year's estimate.

The *Topical Essay* gives some perspectives on uranium inventory.

The *Raw Materials* section covers the **Republic of South Africa's** East Rand Gold & Uranium Company Limited (Ergo), which recovers gold and uranium from tailings of mining and milling operations.

This Executive Summary may be reproduced for internal distribution.

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NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

June 1980 No. 142

MANAGING EDITOR:
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THE URANIUM MARKET

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FOREWORD

We have implemented a number of format changes with this month's Report, including a different typeface and sequential page numbers. As always, Subscribers' comments are welcomed.

A new section on Optimum Tails Assay has been added to the Statistical Data section of the Report. The optimum tails assay will be calculated monthly, using the Exchange Value for the month along with the USDOE separative work price for fixed-commitment enrichment contracts.

Subscribers are reminded that the Exchange Value is available from all Nuexco Representatives after 8:00 a.m. San Francisco time on the first business day of the month.

NUEXCO

URANIUM MARKET

GENERAL

Supply and Demand Balance

In Report 135, Nuexco published an analysis of world uranium supply and demand. The analysis concluded that:

1. *Firm supply* (defined as supply from uranium production centers operating or under construction) appeared more than sufficient to satisfy *consumption* (defined as uranium entering the enrichment-fabrication pipeline) on a worldwide basis through 1990.

2. In addition, firm supply appeared adequate to sustain a worldwide inventory level of approximately two years forward consumption.

Nuexco has re-estimated both apparent future consumption (Report 140) and future firm supply of uranium (Report 141). The resulting changes in the worldwide supply and demand balance are discussed below, following a few prefatory comments on computational groundrules and definitions.

1. Nuexco's estimates of apparent future consumption are sometimes confused with estimates of uranium burnup in reactors. Actually, apparent future consumption, as defined by Nuexco, is natural uranium concentrate which utilities will need to deliver in a given year for enrichment and fabrication and later use in a reactor. Thus, *consumption* is the fundamental component of uranium demand.

2. Anticipated future production from uranium production centers currently operating or under construction as of the date of the estimate is defined as *firm supply*.

3. The critical assumption in this supply-demand analysis is that uranium production centers in operation or currently under construction will be able to sell their projected U_3O_8 output, even if only for inventory accumulation in a time of apparent excess supply.

4. To the extent that actual annual demand exceeds consumption, inventory is accumulated.

5. Planned production centers—those with production plans and identified ore reserves, but for which construction has not yet begun—are not considered in this analysis under the definition of firm supply.

6. It is important to note that estimates of apparent future consumption take no account of reactors not yet ordered. Consequently, consumption estimates will understate actual demand by the amount attributable to orders yet to be placed, as well as by inventory purchases.

7. In order to facilitate understanding of the concept of apparent future consumption, Nuexco's methodology is summarized as follows:

a. Apparent future consumption should be regarded as a comparatively hard component of total demand, and is relatively insensitive to uranium prices. Market demand for the assumed pattern of additions to nuclear generating capacity can be higher, but is not likely to be much lower.

b. Actual demand can exceed apparent future consumption because of accelerated reactor construction schedules or inventory purchases by utilities.

c. Reactor loading is calculated for each reactor, based on its individual core characteristics. It is assumed that: 1) U_3O_8 deliveries for first cores predate commercial operation by two years; 2) first reload occurs 12 months after commercial operating date, and annually thereafter; 3) U_3O_8 delivery for each reload predates reload by 18 months.

d. Actual commercial operating dates can differ widely from published dates. Nuexco uses the best information available, much of it from unpublished sources.

e. These estimates make no provision for orders not yet placed. Only the consumption associated with reactors operating, under construction or on order is included.

f. Reactors fueled by the USSR are excluded.

8. Inventory refers to natural uranium inventory (U_3O_8 and UF_6) owned by utilities, reactor manufacturers, fuel fabricators and national organizations which procure uranium for commercial purposes. The inventory amounts do not include strategic stockpiles, such as those owned by the US Department of Energy (USDOE). Difficulties in accounting precisely for the variety of possible forms, locations and ownership of uranium inventory necessarily result in some uncertainty in estimating the total world natural uranium inventory. Nuexco's estimate of worldwide commercial natural uranium inventory as of the beginning of 1979 is approximately 160 million pounds; however, the uncertainty factor of this estimate is ten to fifteen percent. More important is the fact that the primary conclusions of this analysis are not sensitive to beginning inventory variations of ten to fifteen percent.

Analyses of the uranium supply and demand balance were conducted for each of the following regions: (1) world outside Communist areas (WOCA); (2) US; (3) non-US WOCA.

Table 1 tabulates Nuexco's analysis of the uranium supply and demand balance for the world outside Communist areas (WOCA). Conclusions which may be drawn from the analysis include the following:

1. Firm supply exceeds consumption in each year through 1990, so supply and demand are balanced by additions to inventory. In actual practice, if supply exceeds demand over an extended period, the necessary balance would probably result from a combination of inventory purchases and reduced production.
2. The world inventory of 160 million pounds at the beginning of 1979 is equivalent to 2.3 years of forward consumption at the 1979 rate. The analysis indicates that inventory more than double, to approximately 400 million pounds U_3O_8 by 1990. That inventory corresponds to approximately 3.5 years forward consumption at the 1990 rate. This figure is in contrast to the data published just seven months ago in Nuexco Report 135. At that time, this same type of analysis indicated a fairly stable relative inventory level of 2.0 to 2.3 years forward consumption.
3. If actual demand is to be sufficient to support production from production centers planned, but not yet under construction, it may arise from new reactor orders, or from political or national policy considerations. However, it is more likely that the driving force behind any such additional production entering the market would be to supplant other higher-cost production centers.

Table 2 shows Nuexco's current analysis of the uranium supply and demand balance for the US. By treating the US alone, the potential market can be identified not only for imports, but also for potential US production centers not yet under construction.

The analysis in Table 2 is of the same basic form described above, but with the addition of an adjustment for *existing* US export-import commitments, as set forth in Table 3. The result is an annual supply surplus or deficit for the US. If the annual result is a supply surplus, it is assumed to have been added to buyer inventories. If the annual result is a supply deficit, it is assumed to have been removed from buyer inventories. The annual beginning and ending inventory levels are also tabulated in Table 2 along with the relative inventory level for that year, in years of forward consumption. Table 2 indicates the annual US supply deficit beginning in 1981 and growing to an annual level of 24 million pounds in 1990. Without additional imports or new US supply, US inventory would decline to a level equivalent to 18 months forward consumption by 1983. Under the groundrules of this analysis, US inventories would be completely liquidated in 1987.

Based on these results, it would appear that the US will be dependent to a large extent upon imported uranium by the mid-1980's. Thus it is likely that US users, as a group, will desire to maintain a commercial inventory of uranium. Tables 4 and 5 were developed under the assumption that US utilities would maintain a collective inventory level equivalent to at least 18 months forward consumption. The two most important assumptions in computing the data in Table 4 are as follows:

1. When, after taking into account exports, imports and annual consumption, annual US production is enough, or more than enough, to maintain inventory equivalent to 18 months forward consumption, any excess production will be added to inventory.
2. When, after taking into account exports, imports and annual consumption, annual US production is insufficient to maintain inventory equivalent to 18 months forward consumption, US buyers will acquire the additional uranium through some combination of increased imports, increased purchases from US facilities denoted as firm supply, and purchases from new US production centers not yet under construction.

If, as assumed in Table 4, US buyers maintain a minimum inventory level of 18 months forward consumption, an *unfilled US demand* would be created as follows (millions of pounds U_3O_8):

	1984	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*
Annual	15.1	18.3	21.0	23.5	25.5	22.7	24.1
Cumulative	15.1	33.4	54.4	77.9	103.4	126.1	150.2

Thus, if US buyers' inventory policies take the form assumed in Table 4, the cumulative market for imports and new additions to US production will total approximately 150 million pounds U_3O_8 through 1990. This figure is substantially higher than in the previous Nuexco estimate, published in Report 136. The increase in *unfilled US demand* is primarily due to decreased Nuexco estimates in US *firm supply*. Thus it is likely that most of the uranium which would be needed to meet unfilled US demand will be imported.

Nuexco Report 136 contained the following paragraph which described the circumstance which would tend to increase the market for imports above the levels estimated in that Report:

> *Shifting economics may result in the premature closing of some US production listed as "firm supply." Although this analysis has accounted for estimated depletion of reserves, it is possible, perhaps even likely, that some operating production centers in the US will shut down prematurely due to unfavorable economics. The real price of uranium has been decreasing for about two years, and some US producers are expecting a cost squeeze which may make cutbacks necessary in economically marginal facilities. Since US production costs are generally higher than those of other uranium-producing nations, a prolonged buyers' market may tend to shift production out of the US.*

The situation described above has become more evident with the decline in the Exchange Value by more than 20 percent in the past six months. At the same time, increasing world inventory levels have heightened the possibility of a prolonged buyers' market. Consequently, Nuexco's estimate of US firm supply has decreased, and thus its estimate of unfilled US demand has increased substantially, to 150 million pounds U_3O_8, cumulative through 1990.

Other factors which would tend to further increase unfilled US demand above the current estimate are:

1. More export commitments will be made. This is not expected to be a major influence, but any new commitments to export uranium will increase the unfilled US demand estimate.

2. New reactors may be ordered. However, due to long construction lead times in the US, new reactors are not expected to add significantly to demand until after 1990.

If the US imports an additional 150 million pounds U_3O_8 through 1990, the effect on the rest of the world's uranium supply and demand balance could be substantial. Table 5 was developed to estimate this effect. Table 5 tabulates the supply-demand balance of the world outside the US and outside Communist areas, under the assumption that the US will import as necessary to maintain at least 18 months forward consumption in inventory. The analysis indicates an increase in relative inventory level from 2.8 years at the beginning of 1980 to more than 5 years by 1990. Even after projected exports to the US are deducted from firm supply, there is a substantial supply surplus in each year through 1990. This analysis shows inventories outside the US nearly tripling, from approximately 113 million pounds in 1980 to 320 million pounds in 1990.

Some general conclusions which may be drawn from this analysis are as follows:

1. Delays and cancellations of reactor projects combined with apparently ample future uranium availability are leading to an increasingly competitive uranium market.

2. Because the market is expected to be so competitive, the decade ahead is likely to be one in which high cost producers will phase down operations and low cost producers will begin phasing up.

3. The principal high cost producers are in the US. The principal low cost production potential is in Australia and western Canada. Whatever production capacity is added either to meet expanded demand, to compensate for depleting operations or to supplant production which becomes uneconomic will come largely from the latter areas.

4. While greatly expanded production from Australia and western Canada is no longer *essential* to fulfill world needs over the next decade, it remains clear that these areas will have a major future role because of their favorable economics of production.

5. Utility inventory policies will continue to be an especially important factor in determining the complexion of the uranium-producing sector during the 1980's.

Table 1

NATURAL URANIUM SUPPLY-DEMAND BALANCE: WOCA[1]

(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[2]												
Operating Production Centers	98.5	104.2	109.1	110.3	110.0	108.5	108.0	106.0	105.3	105.1	105.1	105.1
Facilities under Construction	-0-	1.0	6.8	9.3	13.6	18.5	20.6	21.6	21.6	21.6	21.6	21.6
Firm Supply	98.5	105.2	115.9	119.6	123.7	127.0	128.6	127.6	126.9	126.7	126.7	126.7
less												
CONSUMPTION[3]	68.7	69.6	88.1	96.4	103.5	107.2	112.0	109.0	110.1	112.5	114.2	113.5
equals												
NET INVENTORY INCREASE	29.8	35.6	27.8	23.2	20.2	19.8	16.6	18.6	16.9	14.2	12.5	13.2
plus												
BEGINNING INVENTORY	160.0	189.8	225.4	253.2	276.4	296.6	316.4	333.0	351.6	368.4	382.6	395.1
equals												
ENDING INVENTORY	189.8	225.4	253.2	276.4	296.6	316.4	333.0	351.6	368.4	382.6	395.1	408.3
RELATIVE INVENTORY[4] (yrs)	2.3	2.7	2.6	2.6	2.7	2.8	2.8	3.1	3.2	3.3	3.4	3.5

[1] World outside Communist areas.

[2] Ref. Nuexco Report 141, pg. 1.4.

[3] Natural uranium entering enrichment-fabrication pipeline for later use in a reactor. Ref. Nuexco Report 140, pg. 1.1.

[4] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Table 2
NATURAL URANIUM SUPPLY-DEMAND BALANCE: US
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[1]												
Operating Production Centers	37.0	35.1	32.6	32.0	30.0	26.4	25.9	23.0	22.4	22.3	22.3	22.3
Facilities Under Construction	-0-	0.7	2.4	2.9	3.4	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Firm Supply	37.0	35.8	35.0	34.9	33.4	30.2	29.7	26.8	26.2	26.1	26.1	26.1
less												
CONSUMPTION[2]												
Reactors Now Operational	16.3	17.6	17.7	17.4	17.9	18.2	18.4	17.8	18.3	18.4	18.3	17.8
Now Under Construction	8.5	10.9	19.7	22.5	24.6	23.6	23.1	25.3	25.5	25.5	25.2	25.2
Now On Order	-0-	-0-	-0-	-0-	2.0	2.4	4.8	4.4	4.3	5.6	7.8	7.3
Total	24.8	28.5	37.4	39.9	44.4	44.2	46.4	47.5	48.1	49.6	51.3	50.3
plus												
NET IMPORTS (EXPORTS)[3]	(1.8)	(1.9)	0.3	1.5	1.2	1.7	0.1	0.6	0.6	0.6	1.0	1.1
equals												
SUPPLY SURPLUS (DEFICIT)	10.4	5.4	(2.1)	(3.5)	(9.8)	(12.3)	(16.6)	(20.1)	(21.3)	(22.9)	(24.2)	(23.1)
plus												
BEGINNING INVENTORY	66.4[4]	76.8	82.2	80.1	76.6	66.8	54.5	37.9	17.8	-0-	-0-	-0-
equals												
ENDING INVENTORY	76.8	82.2	80.1	76.6	66.8	54.5	37.9	17.8	-0-	-0-	-0-	-0-
RELATIVE INVENTORY (yrs)[5]	2.7	2.7	2.2	2.0	1.7	1.5	1.2	0.8	0.4	-0-	-0-	-0-

[1] Ref. Nuexco Report 141, pg. 1.2.

[2] Ref. Nuexco Report 140, pg. 1.1.

[3] Ref. Table 3, below.

[4] George F. Combs, Jr.: "The US Uranium Market—1978-1979" USDOE; Grand Junction, Colorado; October, 1979.

[5] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Table 3

US IMPORT-EXPORT BALANCE[1]

(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
IMPORTS												
Annual	6.1	5.6	6.6	6.8	5.5	4.9	2.1	2.0	2.0	2.0	2.0	2.0
Cumulative	6.1	11.7	18.3	25.1	30.6	35.5	37.6	39.6	41.6	43.6	45.6	47.6
EXPORTS												
Annual	7.9	7.5	6.3	5.3	4.3	3.2	2.0	1.4	1.4	1.4	1.0	0.9
Cumulative	7.9	15.4	21.7	27.0	31.3	34.5	36.5	37.9	39.3	40.7	41.7	42.6
NET IMPORTS (EXPORTS)												
Annual	(1.8)	(1.9)	0.3	1.5	1.2	1.7	0.1	0.6	0.6	0.6	1.0	1.1
Cumulative	(1.8)	(3.7)	(3.4)	(1.9)	(0.7)	1.0	1.1	1.7	2.3	2.9	3.9	5.0

[1] Does not include contracts currently under litigation

Table 4

NATURAL URANIUM SUPPLY-DEMAND BALANCE: US

(Assumes US Buyers Maintain At Least 18 Months Forward Consumption in Inventory)
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
CONSUMPTION[1] × 1.5	37.2	42.8	56.1	59.9	66.6	66.3	69.6	71.3	72.2	74.4	77.0	75.5
less												
BEGINNING INVENTORY	66.4[2]	76.8	82.2	80.1	76.6	66.8	69.6	71.3	72.2	74.4	77.0	75.5
plus												
ANNUAL SUPPLY DEFICIT (SURPLUS)[3]	(10.4)	(5.4)	2.1	3.5	9.8	12.3	16.6	20.1	21.3	22.9	24.2	23.1
plus												
MINIMUM INVENTORY INCREASE[4]	-0-	-0-	-0-	-0-	-0-	3.3	1.7	0.9	2.2	2.6	(1.5)	1.0
equals												
UNFILLED US DEMAND[5]	-0-	-0-	-0-	-0-	-0-	15.1	18.3	21.0	23.5	25.5	22.7	24.1
ENDING INVENTORY[6]	76.8	82.2	80.1	76.6	66.8	69.6	71.3	72.2	74.4	77.0	75.5	76.5
RELATIVE INVENTORY (yrs)[7]	2.7	2.7	2.2	2.0	1.7	1.5	1.5	1.5	1.5	1.5	1.5	1.5

[1] 1.5 times apparent future consumption from Nuexco Report 140, pg. 1.1.

[2] George F. Combs, Jr.: "The US Uranium Market—1978-1979" USDOE; Grand Junction, Colorado; October, 1979.

[3] Ref. Table 2, above.

[4] Needed to make Ending Inventory (year N) equal 1.5 times Consumption (year N +1).

[5] Unfilled US demand is defined as that additional amount of uranium, if any, which US buyers would have to purchase over and above US firm supply in order to maintain a minimum relative inventory of 1.5 years forward consumption.

[6] Ending Inventory is derived as the greater of [Beginning Inventory less Annual Supply Deficit (Surplus)] and [1.5 times the following year's Consumption].

[7] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Table 5

NATURAL URANIUM SUPPLY-DEMAND BALANCE: WOCA OUTSIDE US

(Assumes US Maintains Minimum Inventory of 18 Months Forward Consumption by Importing)

(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[1]												
Operating Production Centers	61.5	69.1	76.5	78.3	80.1	82.1	82.1	83.0	82.9	82.8	82.8	82.8
Facilities Under Construction	-0-	0.3	4.4	6.4	10.2	14.7	16.8	17.8	17.8	17.8	17.8	17.8
Firm Supply	61.5	69.4	80.9	84.7	90.3	96.8	98.9	100.8	100.7	100.6	100.6	100.6
less												
CONSUMPTION[2]												
Reactors Now Operational	19.7	21.2	21.2	21.2	21.2	21.3	21.3	21.3	21.3	21.3	21.3	21.3
Now Under Construction	24.2	19.8	28.8	32.5	29.3	31.6	31.1	29.9	30.2	30.2	30.2	30.2
Now On Order	-0-	-0-	0.7	2.7	8.6	10.1	13.1	10.2	10.5	11.3	11.2	11.5
Total	43.9	41.0	50.7	56.4	59.1	63.0	65.5	61.4	62.0	62.8	62.7	63.0
plus												
NET IMPORTS (EXPORTS)[3]	1.8	1.9	(0.3	(1.5)	(1.2)	(1.7)	(0.1)	(0.6)	(0.6)	(0.6)	(1.0)	(1.1)
plus												
ADDITIONAL EXPORTS[4]	-0-	-0-	-0-	-0-	-0-	(15.1)	(18.3)	(21.0)	(23.5)	(25.5)	(22.7)	(24.1)
equals												
SUPPLY SURPLUS	19.4	30.3	29.9	26.8	30.0	17.0	15.0	17.8	14.6	11.7	14.2	12.4
plus												
BEGINNING INVENTORY	93.6[5]	113.0	143.3	173.2	200.0	230.0	247.0	262.0	279.8	294.4	306.1	320.3
equals												
ENDING INVENTORY	113.0	143.3	173.2	200.0	230.0	247.0	262.0	279.8	294.4	306.1	320.3	332.7
RELATIVE INVENTORY (yrs)[6]	2.1	2.8	2.8	3.1	3.4	3.7	3.8	4.3	4.5	4.7	4.9	5.1

[1] Ref. Nuexco Report 141, pg. 1.2.

[2] Apparent future consumption from Nuexco Report 140, pg. 1.1.

[3] Ref. Table 3, above. Non-US exports equal US imports and vice versa.

[4] Additional Exports to the US needed by the US to maintain a minimum inventory of 18 months forward consumption. Ref. Table 4, above, Unfilled Demand.

[5] Nuexco estimate.

[6] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

AUSTRALIA

As noted in Nuexco Report 140, the **British** Civil Uranium Procurement Organization (BCUPO) has elected not to participate in the equity financing of Energy Resources of Australia (ERA). Although the timetable for British uranium requirements has been extended, the basic reason underlying this decision is the same that has led to the extended and difficult negotiation with the prospective Japanese and German investors: without price concessions, there is little motivation to assume the risks of an equity investment. The argument that an equity position enhances long-term security of supply is less compelling in a period of weakening prices, declining demand and perceived oversupply. Nevertheless, progress in the formation of ERA continues, albeit more slowly than anticipated.

A key Australian government requirement for inclusion in Australian uranium supply contracts is agreement by buyers to accept, with five years prior notice with respect to conversion, and eight years prior notice with respect to enrichment, up to 35 percent of scheduled deliveries in the form of natural or enriched UF_6. This requirement relates to deliveries after 1990 to the extent that such services are available in Australia on competitive commercial terms. In view of the uncertainty surrounding the prospects for Australian conversion and enrichment, this requirement has been objectionable to buyers, especially those with long-term obligations for conversion and enrichment. Originally, the Australian announcement of intent to develop enrichment capability was met with a good deal of skepticism worldwide, particularly in view of the apparent glut of enrichment capacity. However, recent developments have increased the credibility of the Australian position. Specifically, USDOE has indicated interest in participating in a multi-national, Australian-based enrichment facility, and the Japanese have reiterated their interest in participating. Thus, buyers may well have to give greater consideration to this aspect of Australian supply.

Commissioning of Queensland Mines' Nabarlek mill is now well advanced and remains on schedule. First production of U_3O_8 is expected this month.

CANADA

Atomic Energy of Canada Ltd. (AECL) and the **Argentine** Comision Nacional de Energia Atomica (CNEA) have agreed to revise an earlier agreement associated with the Candu reactor under construction at Embalse, Cordoba. The revision revolves around the treatment of cost overruns at the Embalse site.

It also extends the period of technology exchange to cover the first years of operation of the reactor, and gives CNEA direct project management of the nuclear side of the project. The resolution of these problems will probably return AECL to a competitive position in regard to future reactor orders from CNEA, provided the two countries can resolve their differences on the nuclear safeguards issue.

Canada's stance on safeguards had tended to put AECL at a competitive disadvantage with other nations in doing business with Argentina. Last year AECL lost to competition from Kraftwerk Union (KWU) of the **Federal Republic of Germany** in its bid to sell a second heavy water reactor nuclear unit to Argentina.

EUROPE

The **Swedish** government has approved the loading of the country's ninth and tenth nuclear units, Forsmark unit 2 (900 MWe BWR) and Ringhals unit 4 (915 MWe PWR). Fuel loading at Forsmark unit 2 will take place in the fall of 1980. It is scheduled to begin commercial operation in 1981. Ringhals unit 4 will be loaded in 1981 and is expected to be commercial by mid-1982. The validity of the licenses is through 1986, at which time evidence must be provided that reprocessing and waste disposal are available, as required by Swedish law.

A recent public opinion poll in **Austria** showed 36 percent of the electorate in favor of nuclear power, 30 percent against. This is a small shift in favor of nuclear power. Sufficient signatures have been collected to start an initiative to rescind the law prohibiting nuclear power generation in Austria, and it is hoped that the move will be put to a vote early in 1981. Parliament would, however, have to sanction such a rescindment. A study undertaken to evaluate the conversion of the 700 MWe Tullnerfeld plant near Zwentendorf to a coal or oil-fired plant proved negative. The utility, GKT, will attempt to preserve the unit in its present state at least through 1984.

The state utility of **Italy**, Ente Nazionale per l'Energia Elettrica (ENEL) has received government sanction for its program for 1980-90. During this period. ENEL plans to add 27,030 MWe of capacity, more than one third of which will be provided by ten 1,000 MWe nuclear units at five different plant sites.

In **Switzerland**, anti-nuclear groups in three cantons have officially launched another initiative to halt all nuclear plants having a start-up date later than January 1, 1985. The main targets of the initiative are the Kaiseraugst and Graben plants. The groups now have 18 months in which to collect the signatures required to put the initiative to a vote.

The Central Electricity Generating Board (CEGB) of the **UK** has issued a letter of intent to the British National Nuclear Corporation for the 1,100 MWe PWR at Sizewell in Essex. The UK plans to increase nuclear generating capacity by 15,000 MWe through 1990.

Some within the **Federal Republic of Germany** continue to express concern that German industry will become uncompetitive with **French** industry because of the latter's heavy reliance on cost-effective nuclear power. They point out that a nuclear unit in France would be expected to cost only 70% of what a comparable unit would cost in Germany, and that gap can be expected to widen as the French forge ahead with their accelerated nuclear power program. The cost differential arises from the longer construction time in the FRG due to licensing logjams, as well as the benefits derived from standardization by the French of their nuclear hardware and licensing procedures.

In 1980, a new political party in the FRG known as the "Greens" has developed. The Greens are an environmentalist, strongly anti-nuclear party intent on shutting down operating nuclear plants and preventing new ones from coming on line. The Greens have surprised many by managing to capture enough of the popular vote to place candidates in some of the state legislatures.

Despite these problems, the FRG brought three new nuclear units with a combined generating capacity of about 3,100 MWe on line in 1979.

Last month, the German firm Kraftwerk Union (KWU) signed a contract with the **Argentine** CNEA for a 745 MWe natural uranium heavy water reactor at the Atucha site. The first Atucha unit was supplied by KWU/Siemens.

FAR EAST

The **People's Republic of China** (PRC) has apparently rekindled its interest in nuclear power. It is proceeding with plans to build two 900 MWe nuclear units near Canton. China Power and Light of Hong Kong has agreed to purchase 40 percent of the power, and will finance 40 percent of the plant on the basis of equivalent plant cost elsewhere, i.e. outside the PRC.

The leading contenders to supply the nuclear units are Framatome (**France**), National Nuclear Corporation (**UK**) and Westinghouse (**US**). Framatome is apparently attempting to have the two plants which had previously been negotiated for the Shanghai area (but later cancelled) reinstated as orders for the Canton site. The French are offering a good financing package, and are not requiring safeguards. These are seen as advantages for Framatome. The US State Department has indicated that since the PRC is a nuclear weapons state under the Non-proliferation Treaty, full-scope safeguards would not be required under the bilateral agreement for cooperation which the US State Department hopes to negotiate with the PRC this year. That is, only the material and technology transferred would be subject to safeguards. The latter would be an advantage to Westinghouse; however, there is no assurance that US Export-Import Bank financing would be available, which might be a disadvantage. Britain's National Nuclear Corporation is offering a PWR based on the Westinghouse license. The presence of Hong Kong financing must be regarded as an advantage for the British.

In addition to the two units for Canton, two units in the Shanghai area, and two more in the northern part of the country are in planning.

UNITED STATES

The US Department of Energy (USDOE) has published its latest estimate of US uranium reserves. The estimate indicates that US reserves producible at a forward cost of $50 per pound U_3O_8 or less increased slightly to 956,000 tons U_3O_8 as of January 1, 1980, from 920,000 tons the year before. About 93,000 tons were added to reserves in this cost category in 1979; however, 57,000 tons were removed because of cost increases and revaluation, and 20,000 tons of reserves were mined to yield approximately 37 million pounds U_3O_8 (after mill losses) produced in the US last year.

URANIUM MARKET

The average grade of ore mined in the US last year was 0.11 percent U_3O_8. Nuexco estimates that the average grade of ore mined in the US during 1980 will fall below 0.10 percent U_3O_8. For comparison, according to USDOE, the average grade of all US reserves recoverable at a forward cost of $50 or less ranges from 0.09 percent in New Mexico to 0.05 percent in Texas.

The term *forward cost*, as used by USDOE, includes only forward capital and operating costs. It does not include recovery of sunk costs, interest, return on investment or income taxes. Thus, the price necessary to exploit reserves economically would be considerably higher than the forward cost. The concept of forward cost was discussed in detail in Nuexco Report 138.

The US Nuclear Regulatory Commission (NRC) unanimously voted to refuse an export license for enriched uranium intended for India's Tarapur plant. The reason given for the NRC refusal was that India is not a party to the Non-proliferation Treaty, and therefore the NRC Commissioners felt that exporting to India would not meet the criteria of the 1978 US Nuclear Non-Proliferation Act (NNPA). President Carter has the authority under the NNPA to overturn the NRC finding. However, Congress, in turn, has 60 legislative days in which to override the President's action by concurrent resolution (i.e. both the House and the Senate must vote to override the President's decision). It is likely that the Tarapur issue will ultimately be decided by Congress.

Three nuclear units have been licensed for low power testing by the NRC this year. They are Sequoyah unit 1 (Tennessee Valley Authority), North Anna unit 2 (Virginia Electric and Power Co.) and Salem unit 2 (Public Service Electric & Gas Co.). Additional approvals must be obtained for power generation. The next unit to receive such a low power license is likely to be La Salle unit 1 (Commonwealth Edison Co.). Other units which may soon follow include Zimmer (Cincinnati Gas & Electric Co.), McGuire unit 1 (Duke Power Co.), Summer (South Carolina Electric & Gas Co.), Watts Barr unit 1 (TVA), Shoreham (Long Island Lighting Co.) and Diablo Canyon units 1 and 2 (Pacific Gas & Electric Co.).

TRANSACTIONS

Four transactions are reported this month, of which only one is for near-term delivery. Two of the transactions, each under 600,000 pounds, involve US producers selling to buyers located in France and the Federal Republic of Germany; one of these is a production output contract (i.e. buyer obligated to take seller's production, if seller produces). In both cases the price is fixed, and one involves payments in advance of delivery. The German buyer is a utility; the French buyer is a producer.

The other two transactions involve Canadian producers as sellers. The smaller of the two transactions, under 300,000 pounds, is for immediate delivery at a fixed price near current Exchange Value. The buyer is a European utility. The larger transaction has a price related to the market price at the time of delivery, with a floor price, escalated. This deal involves over four million pounds. The buyer is a Far East utility.

PRICING

The **Exchange Value** remained unchanged this month at $32.00 per pound U_3O_8. Downward pressure on the market was relieved somewhat by the return of lower interest rates and more plentiful loan money. Therefore, some of the US utility sellers have reduced their efforts to sell.

Inquiries to sell material for 1980 delivery involve a total of 4.2 million pounds U_3O_8. However, the sellers of a substantial portion of that material have not been willing to consider a sale at a price as low as current Exchange Value. Some sellers, however, have been willing to reduce offer prices, and a few potential transactions are under discussion as a result. Inquiries to purchase for 1980 delivery involve a total of 1.2 million pounds U_3O_8. The potential buyers include uranium producers, but it is significant that utility buyers have returned to the market. Near-term inquiries have surfaced in Europe, as have spot, intermediate and long-term inquiries in the United States. It appears that at least some utility buyers believe the market is nearing, or has achieved, a bottom, and are hoping to acquire material at what they view as attractive prices. Decisions to enter the market after a short period of rapid price decline also suggest that some buyers believe the bottom may be of short duration, with the possibility that the sharp price decline could be followed quickly by an equally vigorous rebound. The extent and speed of any rebound will depend largely on how aggressively the current inquiries are pursued by the prospective buyers.

Another indication that prices may be bottoming involves the participation in the market of producer-buyers. To the extent that near-term market price falls, producer interest in buying, rather than making, should increase accordingly. Figure 1 indicates Nuexco's estimate of the distribution of current US uranium production costs. The horizontal axis represents full production costs (i.e. variable and fixed costs), excluding return on investment. The vertical axis represents the percentage of US producers whose average production cost is higher than the cost indicated at any point on the curve (i.e. Figure 1 is an integral cost distribution).

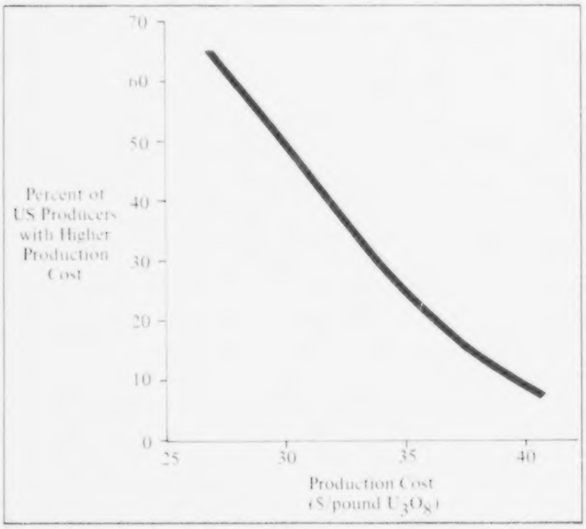

Figure 1
ESTIMATED DISTRIBUTION OF US URANIUM PRODUCTION COST

Figure 1 might suggest that at the current Exchange Value of $32.00 per pound U_3O_8, there would be substantial interest among US producers in buying, rather than producing, to make deliveries under existing contracts. However, Figure 1 probably overstates potential producer interest in buying. The producer's cash flow may continue to be favorable for production, even if cost accounting would indicate that purchasing is economically more beneficial. This is because there are usually certain fixed costs which have to be met, regardless of the output level of a production center. Also, some mines cannot be shut down without irreparable damage.

However, Figure 1 does indicate how purchasing activity by producers can serve to underpin the market. As prices decrease, more producers find it more attractive to buy, rather than to produce, thus putting upward pressure on the market, even if utility buyers are inactive. The uranium market appears to be at or near the level at which there might be sufficient producer interest to forestall the continued rapid collapse in prices experienced over the past few months.

The **Transaction Value** decreased somewhat this month to $37.90 per pound U_3O_8. The Transaction Value is still largely influenced by transactions which closed as long as four months ago, when prices were much higher. The Transaction Value sample must have a minimum of ten transactions totaling at least two million pounds, and must include transactions closing over a minimum of three months (see Statistical Data section of this Report for complete definition). This built-in inertia in determining Transaction Value will always cause it to lag changes in the Exchange Value.

TOPICAL ESSAY

SOME PERSPECTIVES ON URANIUM INVENTORY

Introduction

Uranium inventory is becoming an increasingly important presence in the market. The near-term market has been greatly affected by the inventory policies of US utilites over the past several months. Relatively large amounts of material have been offered for sale by US inventory holders, thus contributing to downward pressure on near-term market prices.

The purpose of this essay is to:

- analyze the current inventory status
- review the factors which led to the current inventory position
- discuss the trends developing in inventory practices
- consider the implications for the uranium market.

This essay focuses on inventories in the US, since US inventory practices seem to be having the greatest effect on the near-term market. The conclusions, however, apply generally to the world market.

Current US Inventory Status

For purposes of this essay, inventory is defined as uranium owned by users, in the form of natural concentrates or natural UF_6. A related definition is that changes in the aggregate industry inventory level result from the difference between production and consumption of uranium, where consumption is defined as natural uranium which enters the enrichment-fabrication pipeline for later use in a reactor. While this statement seems obvious, it highlights the fact that inventory is the surge tank between production and consumption of uranium. If producers do not hold significant inventory (US producers do not hold significant inventories; some non-US producers have been observed to hold inventories at times) then it is only the willingness of users to accumulate inventories which enables uranium production to exceed consumption. Worldwide uranium production has, in fact, exceeded consumption in every year of the civilian nuclear power program.

Nuexco's estimates of the recent US inventory situation is outlined quantitatively in Tables 2 and 4, above. At the beginning of calendar year 1980, US uranium inventory was 76.8 million pounds U_3O_8 equivalent by Nuexco's assessment. At the end of 1980, US inventory is expected to be about 82.2 million pounds U_3O_8 equivalent. For the most part, this material is physically located at the facilities of USDOE, or the two US conversion contractors, although relatively small amounts may be stored with non-US converters. In addition to the converters and USDOE, at least two commercial storage facilities are now licensed in the US. However, significant amounts of US-owned inventory has not yet been moved into these facilities.

Table 6 contains Nuexco's estimate of the distribution of US-owned commercial inventories by location, expressed as a percent of total US inventory (currently about 80 million pounds of U_3O_8 equivalent). Table 6 also contains Nuexco's estimate of the chemical form (either U_3O_8—i.e. concentrates—or UF_6) in which the inventory currently exists.

Table 6

ESTIMATED DISTRIBUTION OF US-OWNED COMMERCIAL INVENTORY, BY LOCATION
(percent of total)

Location	as U_3O_8	as UF_6	Location Total
Allied Chemical	22	10	32
Kerr-McGee	21	19	40
USDOE	0	28	28
TOTALS	43	57	100

The US-owned commercial inventory level of about 80 million pounds U_3O_8 equivalent does not include uranium "inventory" owned by USDOE. Nuexco estimates that USDOE now owns approximately 45 million pounds U_3O_8 equivalent, in the form of natural UF_6. In addition, Nuexco estimates that USDOE owns a stockpile of enriched UF_6 containing a feed content of 111 million pounds U_3O_8 equivalent. Thus the total US national stockpile of uranium, outside of fabricated fuel, is about 236 million pounds U_3O_8 equivalent, including both commercial and government-owned inventories. It is interesting to note that the latter figure is about ten times actual US consumption of natural uranium in 1979 (see Table 2, above). Thus the US will clearly not be vulnerable to embargoes from uranium exporting countries for the foreseeable future.

Aside from the US government stockpile, the US commercial inventory level at the end of 1980 is expected to be about 2.7 years forward consumption, or about a 1,000 day forward supply. For comparison, US government studies typically assume an average oil inventory among US utilities of not more than 30 days. Currently, coal inventories among US utilities average about 120 days forward supply. While there is a substantial difference among oil, coal and uranium from the standpoint of inventory measured in days of forward supply, there is very little difference when they are measured in terms of inventory *value*. Table 7 was prepared to demonstrate this. The left-hand column of figures in Table 7 contains the average inventory levels discussed above, for oil, coal and uranium. The middle column represents fuel costs in US dollars per million Btu's of energy content for each fuel. The oil cost of about $6.00/MBtu's is based on current OPEC prices. A typical US coal price is difficult to quantify because of the large variance about the mean, but a delivered price of $1.40/MBtu appears about average in many parts of the country. The natural uranium cost of about $0.18/MBtu is based on the current Exchange Value of $32 per pound U_3O_8. (For reference, $0.18/MBtu includes only the cost of natural uranium. It does not include enrichment or fabrication.) The right-hand column of Table 7 is the product of the first two columns and represents the *relative value* of the fuel inventory, expressed in arbitrary units. As indicated, the average dollar values of US utility inventories of oil, coal and uranium are roughly the same.

Table 7

RELATIVE VALUES OF AVERAGE US UTILITY INVENTORIES OF OIL, COAL AND URANIUM

Fuel	Average Inventory (days forward supply)		Average Fuel Cost ($/MBtu)		Average Inventory Value (arbitrary units)
Oil	30	x	6.00	=	180
Coal	120	x	1.40	=	168
Uranium	1000	x	0.18	=	180

The distribution of relative inventory levels among US utilities is shown in Table 8. The wide distribution indicates there is not really a *normal* inventory position in the US. The clustering in Table 2 below two years inventory suggests a majority of US utilities desires to maintain less than two years inventory. This is consistent with discussions Nuexco has had with uranium users. US utilities holding more than two years forward consumption in inventory usually are doing so because of nuclear plant delays, combined with pre-existing long-term uranium contracts.

Table 8

DISTRIBUTION OF RELATIVE INVENTORY LEVELS FOR US UTILITIES[1]

Years of Forward Consumption in Inventory as of End of 1980	Number of Utilities
0-1	18
1-2	14
2-3	9
3-4	4
4-5	2
5-6	0
greater than 6	9

[1] US median is estimated at 1.5 years as of end of 1980.

Factors Which Led to the Current US Inventory Position

One important factor in the current US position is that much of the inventory was acquired involuntarily. Contracting for U_3O_8 in the late 1960's and early 1970's was based on the then-optimistic outlook for nuclear power growth. Subsequently, delays in licensing and construction reduced consumption, but inventory buildup continued under long-term contracts. Although this buildup was unplanned, another important factor leading to the current high inventory position is that inventories were in fact largely retained rather than avoided by deferrals of deliveries, or by resale of the material. Holding large amounts of inventory became an acceptable practice for several reasons, one of which was assurance of supply, a primary concern because:

- It was difficult to make long-term contracts during the period of rapidly rising price in 1974 and 1975, causing uranium buyers concern about later availability.
- The unprecedented litigation which overtook the uranium industry beginning in 1975 added further uncertainty about supply.
- Finally, there was political uncertainty resulting from events such as Canada's suspension of exports for 12 months while safeguards requirements were in dispute, and the domestic contro-

versy which paralyzed Australia's market entry as a supplier in the 1970's.

Another important factor which allowed large inventories to be carried was the relatively low carrying cost. Although spot market prices exceeded $40 per pound in the late 1970's, the bulk of uranium was delivered under long-term contracts, often at prices considerably below the then-prevailing spot price. Until recently, interest rates were not troublesome to utilities or their regulatory commissions, and the utilities were usually permitted to recover the entire cost of carrying uranium inventories. Thus utilities were not under a great deal of pressure to reduce inventories.

There were also a few less important factors contributing to inventory buildup. Buyers holding long-term contracts with low prices preferred to take delivery under those contracts even if the delivery schedule gave them material far too early, as the result of reactor delays. Buyers often did not negotiate extended delivery schedules, because sellers usually requested to renegotiate prices in exchange. Also, large amounts of uranium were accepted and stored in inventory because it is physically possible to do so conveniently. Unlike oil, coal and gas, uranium requires very little space for storage per unit of contained energy, and is stable indefinitely.

Current Trends in Inventory Management

In the US, there is a definite trend toward carrying lower levels of inventory. This results, in part, from initiative taken by the utilities themselves. In the utility industry, there is increasing emphasis on resource management and, as a result, holding large amounts of inventory is coming under scrutiny. In some cases, audits by management consultants have recommended carrying less inventory.

In addition to a growing disposition to hold less inventory, there is an increasing variety of methods available to manage inventory, and reduce its financial burden. Table 9 lists the sources and uses of uranium inventory. Although most are obvious, some deserve special mention:

- *Loans:* Typically, there are few uranium loan transactions, compared with the number of sales transactions. Assurance of payback is an important consideration. Now that future uranium supply is perceived to be more certain, this consideration is less troublesome, contributing to a greater availability of material available for loan. This should make the industry-wide inventory more fungible, and reduce the driving force *for the individual utility* to increase inventories.
- *Financial Markets:* Sale with a repurchase option or sale with a leaseback are both financing mechanisms for removing inventory from the utility's balance sheet and changing the manner in which uranium is financed. Usually, the inventory remains in storage somewhere and is still therefore an idle asset, but is recorded on a different set of books. Such transactions can improve the utilities' financial position and are being used increasingly in inventory management.

Table 9

FACTORS WHICH CHANGE INVENTORY LEVEL OF INDIVIDUAL HOLDERS

A. **Inventory Sources**
   1. Existing supply contracts
   2. Uranium Market
      a. Spot purchases
      b. Loans
   3. US Government sales or loans from stockpile

B. **Inventory Uses**
   1. Contractual demand for U_3O_8
      a. Conversion schedule
      b. Enrichment schedule
      c. Fabrication schedule
   2. Reactor demand
   3. Disposition via the uranium market
      a. Sale
      b. Loan
   4. Temporary Disposition via the financial market
      a. Sale with repurchase option
      b. Sale with leaseback obligation

EAST RAND GOLD & URANIUM COMPANY LIMITED (ERGO)

Introduction

Anglo-American Corporation of South Africa Limited (AAC) controls 12 mining operations located in the Witwatersrand basin of South Africa. Uranium is recovered in ten of the twelve operations, one of which is the East Rand Gold & Uranium Company Limited (Ergo).*

Ergo recovers gold and uranium from the previously untreated tailings of gold mining and milling operations. Originally, the mined ore was processed for gold only. However, recent refinements in extractive metallurgy make it economically feasible to recover both gold and uranium from the old tailings.

AAC originally re-treated slimes dams in the early 1950's to recover pyrite needed in the production of sulfuric acid, which was used in the by-product recovery of uranium from operating gold mines. These re-treatment operations ceased when demand for uranium declined in the mid-1960's. AAC resumed evaluating slimes dams for gold and uranium in 1973. At that time, geological and metallurgical investigations proved it to be economically feasible to process the slimes to recover those minerals from pyrite. Pyrite is essential to the recovery of the other minerals, since gold and uranium occur in the pyrite concentrate recovered during the flotation process.

Recovering gold and uranium from slimes dams is not a new concept. Throughout the past century, slimes dams have been accumulating in the gold mining districts. Almost without exception, the slimes which accumulated during the first 75 years of mining contain minor quantities of gold and uranium not recovered during the milling process.

Project Development

The Ergo facility uses slimes dams as its sole source of material to be treated for the recovery of valuable minerals. It does not engage in conventional mining and processing of ore. AAC's program in 1974-75 included testing recovery techniques in a pilot flotation plant specially designed to produce a three percent mineral concentrate from incoming slimes. Final feasibility studies indicated that, in order for the program to be viable, at least one million metric tons of slimes per month would have to be re-treated.

Transporting such large volumes of slimes presented new engineering problems. After detailed studies of rail, truck and pipeline transportation, it was concluded that the most economical method is to pump the slimes in slurry form to a central processing plant. Testing at the Vaal Reefs mine showed that the slimes could be broken down quickly and put into slurry form by using high-pressure water jets. The slurry could then be pumped to the processing plant.

During the later stages of the pilot program, AAC began to acquire the mineral rights to specific slimes dams. At least 19 slimes dams were acquired in the East Rand mining district. The dams contain about 400 million metric tons of material, which will be processed over the next 20 years. Figure 2 shows the location of the slimes dams in relation to the main processing plant operated by Ergo.

The decision to proceed with the project was made in January 1976. The initial plan was to pump slurry concurrently from three slimes dams to a central treatment complex. The complex would consist of a flotation plant, a uranium plant, three pyrite roasters, two acid plants and a gold plant. The pyrite concentrate would be treated to recover uranium, then roasted to produce sulfuric acid. Gold would be recovered from the residue resulting from the roasting process. Figure 3 is the basic flow diagram for the Ergo recovery process.

Uranium was first produced at the Ergo facility on February 25, 1978—about two years after construction began. Total expenditures during the construction period were 140 million South African Rand. Sulfuric acid production began on March 14, 1978, and the first gold bar was poured on April 11, 1978. Despite start-up problems, plant production reached an economically acceptable level within 90 days. Technical and mechanical problems persisted, however, and it was about nine months before full-capacity uranium production was achieved. It was a full year before gold and sulfuric acid production reached projected levels.

The Recovery Process

As the first step in development of the project, the slimes dams were sampled for mineral content by auger drilling on 330 and 660 foot centers. The drill

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*Gold is the primary mineral produced at Ergo, not uranium, as reported in Nuexco Report 141, May 1980.

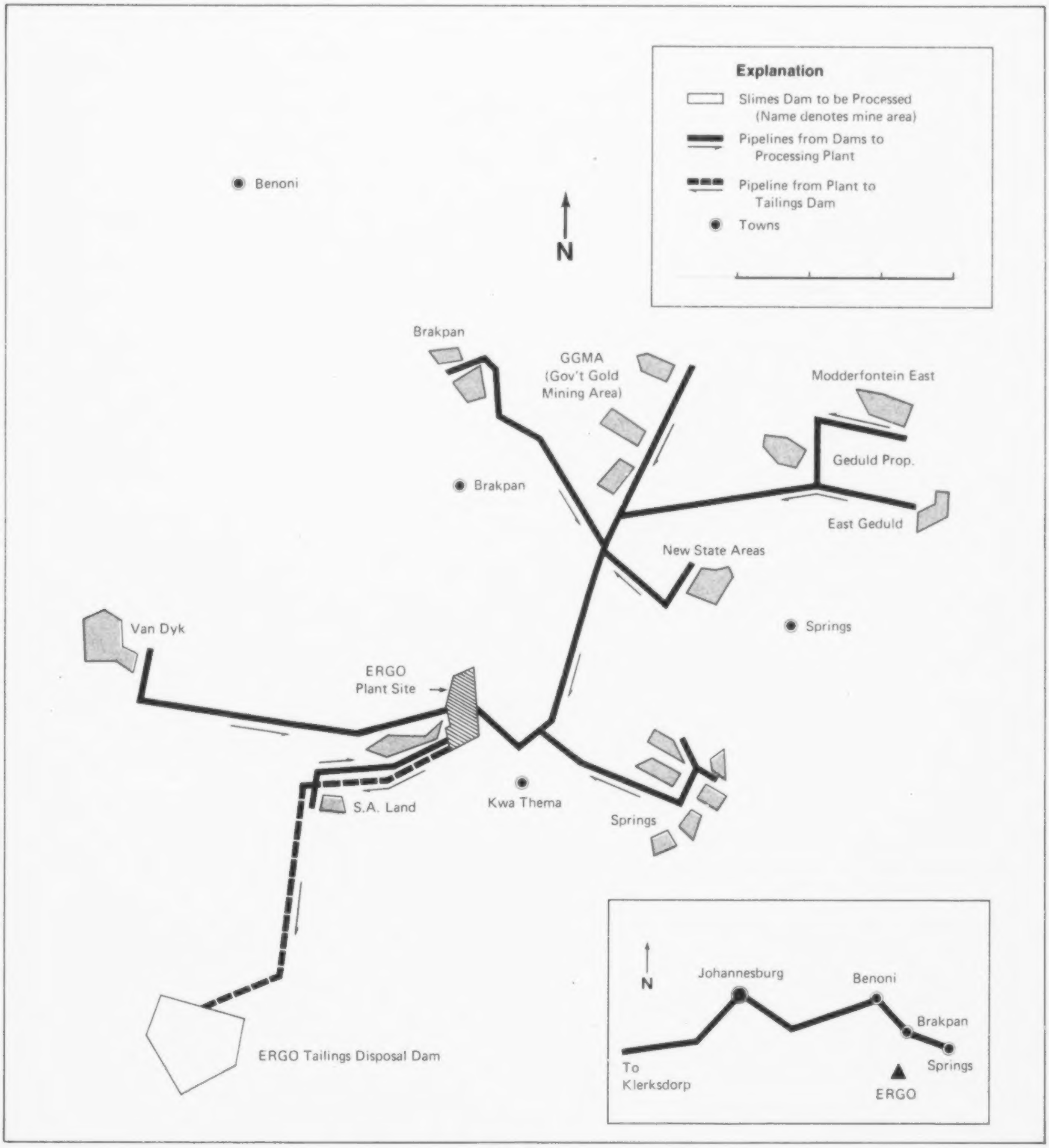

Explanation
Slimes Dam to be Processed (Name denotes mine area)
Pipelines from Dams to Processing Plant
Pipeline from Plant to Tailings Dam
Towns
Benoni
N
Brakpan
GGMA (Gov't Gold Mining Area)
Modderfontein East
Geduld Prop.
Brakpan
East Geduld
New State Areas
Springs
Van Dyk
ERGO Plant Site
S.A. Land
Kwa Thema
Springs
ERGO Tailings Disposal Dam
N
Johannesburg
Benoni
Brakpan
Springs
To Klerksdorp
ERGO

Figure 2
LOCATION MAP OF ERGO PROJECT AREA

samples were divided, with half assayed for gold and half delivered for analysis and metallurgical testing. During the sampling program, 980 holes, totalling about 74,000 feet, were drilled. Approximately one billion metric tons of slimes were evaluated during the test period.

The plan for moving the slimes involves specially-designed, hydraulically-operated water cannons. Water is pumped under high pressure directly into the slimes dam, the face of which is then washed away by the jet of water. A battery of three cannons is utilized on each dam to allow an even advance. Three dams at a time are subjected to water streams, in order to provide the flotation plant with approximately 1.8 million metric tons of material per month.

The slimes wash away from the working face as a slurry, which gravitates to a primary pumping station adjacent to each dam. The slurry from each dam is screened at the site, and pumped in separate pipelines to the flotation plant.

Slurries from the three slimes dams remain separate at the flotation plant, to accommodate any difference in metallurgical characteristics which may exist among the dams. All of the slurry is further prepared for froth flotation by dilution, followed by the addition of sulfuric acid and various chemical reagents. The prepared solution passes through a series of flotation cells, where the valuable mineral concentrate is separated, or floated, out. The tailings are then passed through three huge thickeners, each 454 feet in

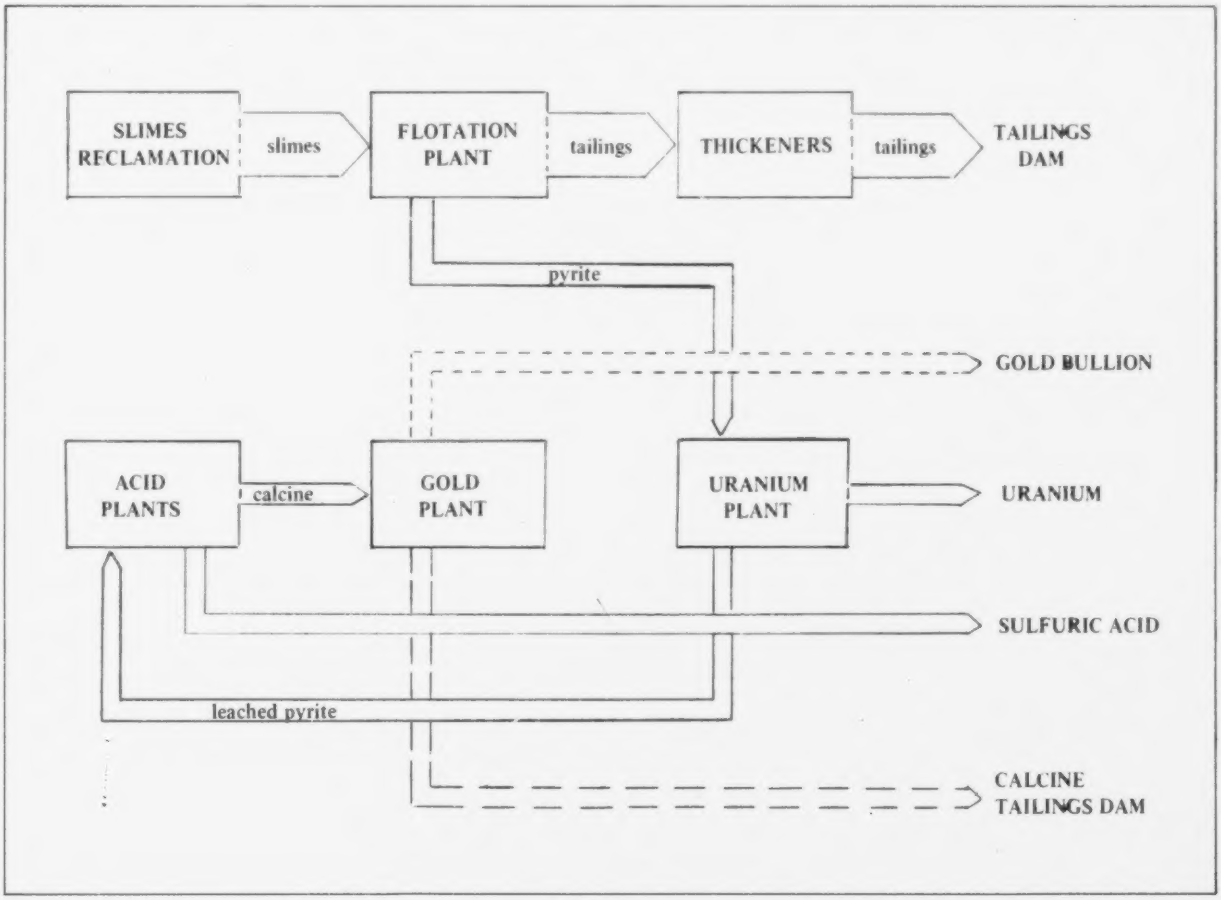

SLIMES RECLAMATION
slimes
FLOTATION PLANT
tailings
THICKENERS
tailings
TAILINGS DAM
pyrite
GOLD BULLION
ACID PLANTS
calcine
GOLD PLANT
URANIUM PLANT
URANIUM
SULFURIC ACID
leached pyrite
CALCINE TAILINGS DAM

Figure 3
ERGO RECOVERY PROCESS FLOW DIAGRAM

diameter, where plant water is recovered. The tailings are then piped to a new and specially-prepared tailings dam area about seven miles from the plant site.

The concentrate from the flotation plant is pumped to the uranium plant, where it is heated by steam. Then follows the addition of sulfuric acid, as required, to dissove the uranium oxide. The leached pulp is directed through a battery of rotary filters which separate the uranium-bearing solution from the pyrite. The solution is further processed by the counter-current liquid ion exchange method, whereby uranium is extracted as ammonium diuranate (ADU). The ADU is trucked in slurry form to the Nuclear Fuels Corporation of South Africa (Pty) Ltd. (NUFCOR) plant for calcining and packaging.

After the uranium has been leached out, the pyrite concentrate is pumped to the two sulfuric acid plants, which have a combined capacity of 1,500 metric tons per day. The concentrate is then passed into fluid-bed roasters, where sulfur dioxide and a residue referred to as calcine are formed. The sulfur dioxide gas is cleaned and, eventually, converted to sulfuric acid, a portion of which is reused in the uranium plant. The calcine, which contains the gold, is quenched with water for pumping to a thickener. After thickening, it is sent as a pulp to the gold plant, where it is polished in a ball mill to expose the surfaces of the gold particles. The pulp then enters a standard cyanidation circuit for extracting gold from slimes. The gold is precipitated by the addition of zinc and lead nitrate. The zinc is removed before the gold is smelted in an electric arc furnace and cast into bars. Figure 4 is a layout of the plant complex; Figure 5 is an aerial photograph of the central plant area.

Production Level

Production capability is building up to a monthly level of more than 32,000 pounds of U_3O_8, 500 kilograms of gold and 40,000 metric tons of sulfuric acid. These are recovered from raw material which has an average "grade" of 0.09 pounds U_3O_8 and 0.53 grams of gold per metric ton, and 1.04 percent sulfur. The average recovery factor is 20 percent for uranium, 55 percent for gold and 86 percent for sulfur. Research continues in order to improve the recovery percentage for each mineral, with emphasis on uranium.

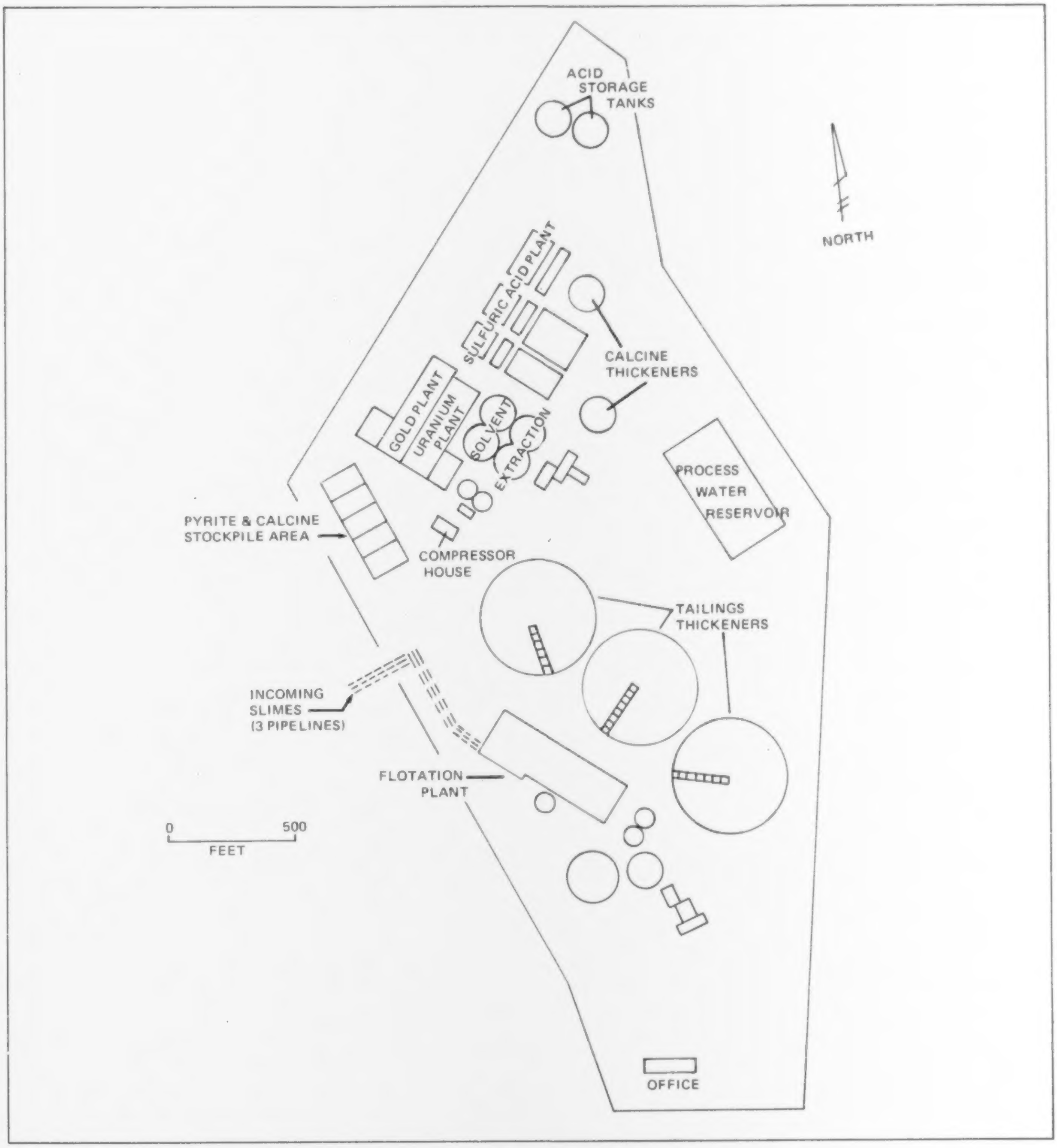

ACID
STORAGE
TANKS
NORTH
SULFURIC ACID PLANT
CALCINE
THICKENERS
GOLD PLANT
URANIUM
PLANT
SOLVENT
EXTRACTION
PROCESS
WATER
RESERVOIR
PYRITE & CALCINE
STOCKPILE AREA
COMPRESSOR
HOUSE
TAILINGS
THICKENERS
INCOMING
SLIMES
(3 PIPELINES)
FLOTATION
PLANT
0
500
FEET
OFFICE

Figure 4
LAYOUT OF ERGO PLANT COMPLEX

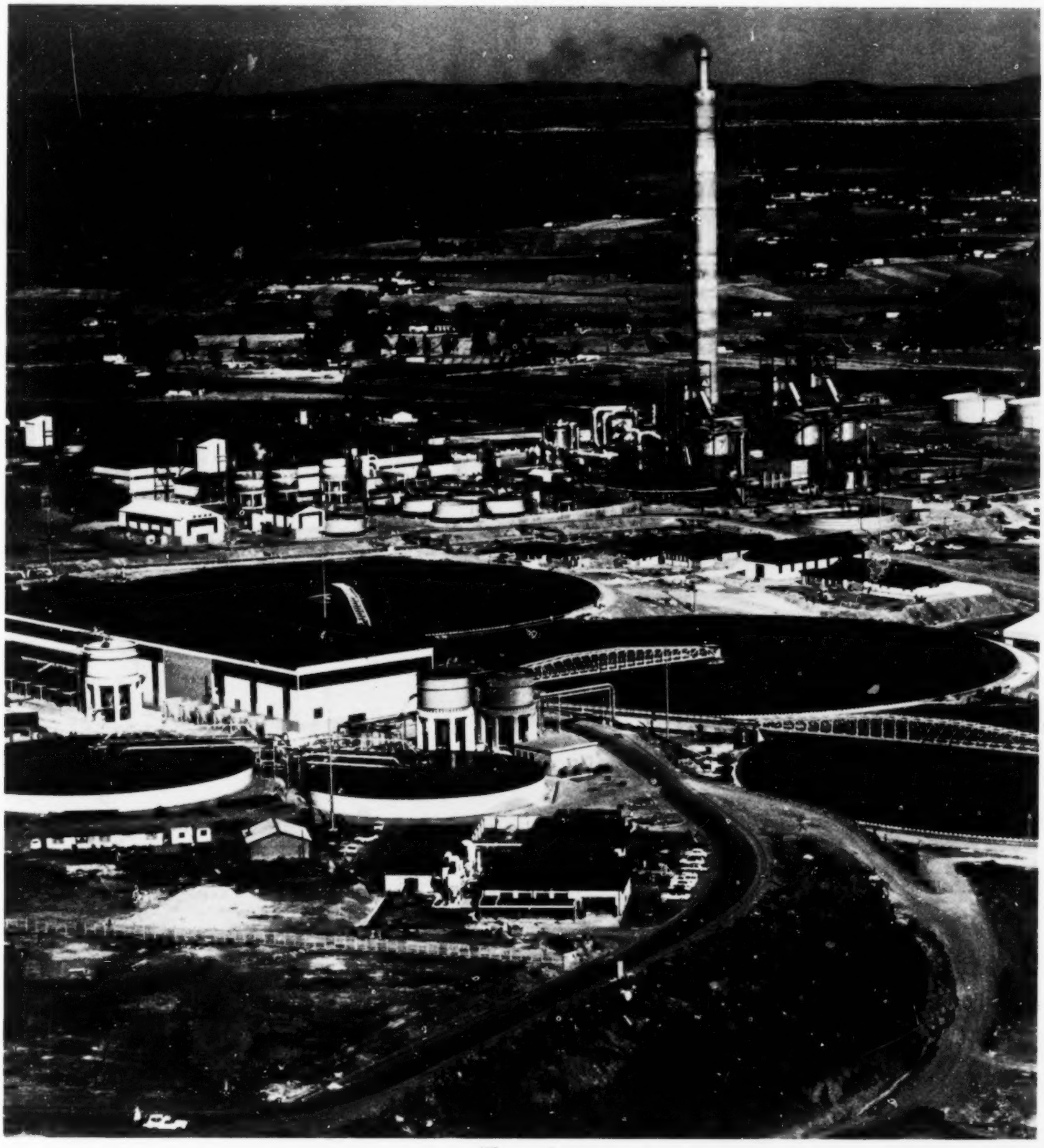


Figure 5
AERIAL VIEW OF ERGO'S CENTRAL PROCESSING PLANT

STATISTICAL DATA

EXCHANGE VALUE—$32.00/lb U_3O_8
Determined as of May 31, 1980

Definition

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of May 31, 1980

$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
37.90	3.9	14	4

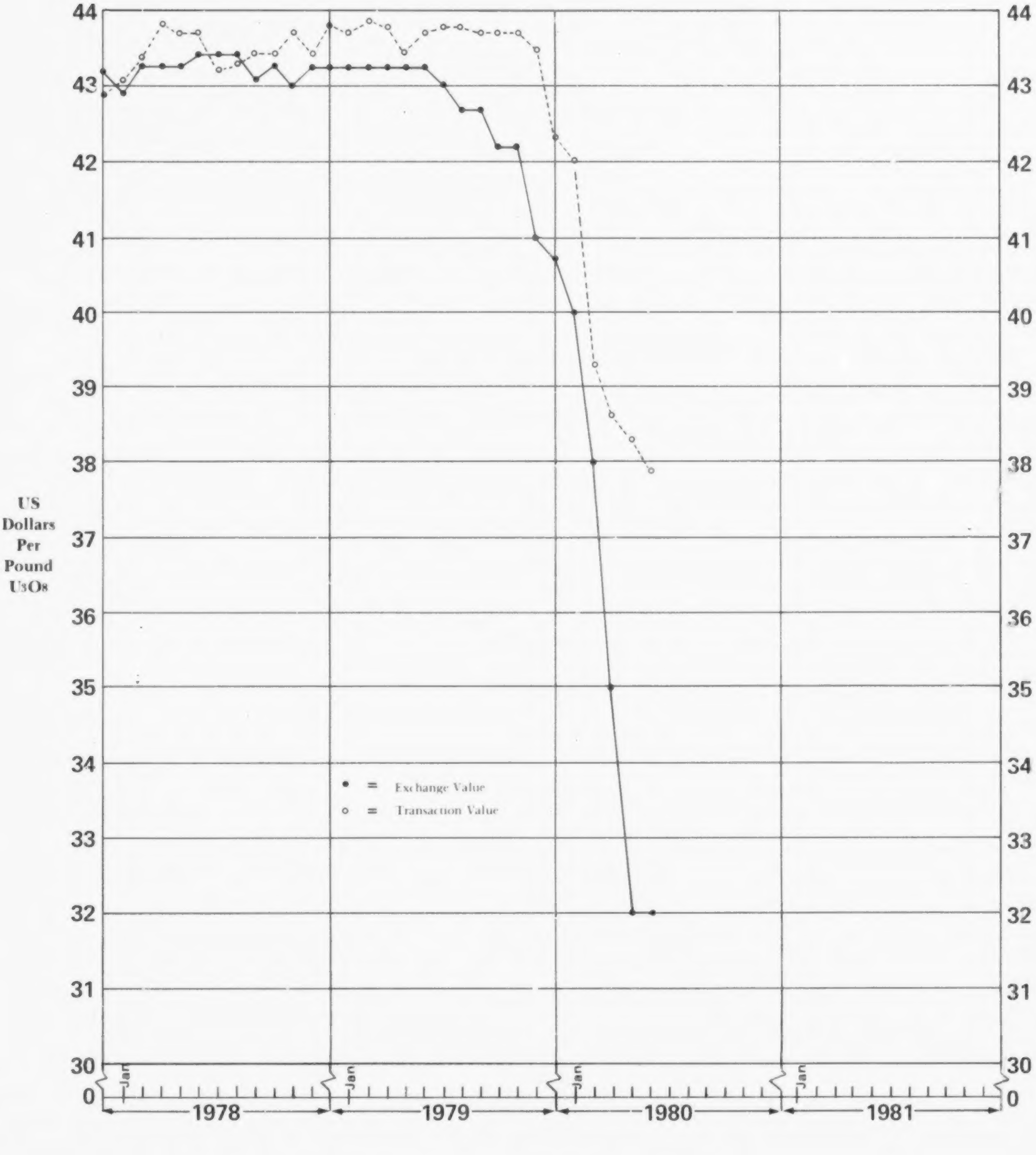
Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES SINCE JANUARY 1977

Determined as of the last day of the month indicated



STATISTICAL DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated
(US Dollars lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00							

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated
(US Dollars lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90							

Note: See Nuexco Report 135 for a discussion of the definition of Transaction Value.

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	32.00	70.55	83.19
France (franc)	132.45	292.00	344.34
FRG (mark)	57.02	125.71	148.24
Japan (yen)	7,193	15,857	18,699
Switzerland (franc)	53.18	117.25	138.26
UK (pound)	13.68	30.17	35.58
Australia (dollar)	27.90	61.51	72.53
Canada (dollar)	37.11	81.82	96.49
Niger, Gabon (CFA)	6,601	14,552	17,160
South Africa (rand)	25.15	55.44	65.38

*Calculated using currency exchange rates published in the Wall Street Journal on the last Friday of the month.

LOAN USE CHARGE RATE—7.0%/year

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Nuexco Reference Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as percent of Current E.V.	Seller Group	Buyer Group	Remarks
1097	80-81	300 to 600	123	US	Europe	
1101	83-84	300 to 600	105	US	Europe	
1120	81-90	4,000 to 7,000	–	Canada	Far East	Price related to market
1135	80	100 to 300	97	Canada	Europe	

---

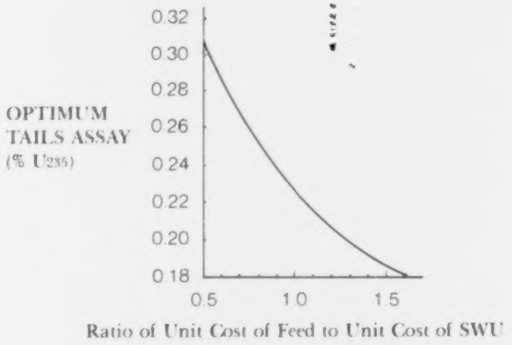
*Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

STATISTICAL DATA

OPTIMUM TAILS ASSAY

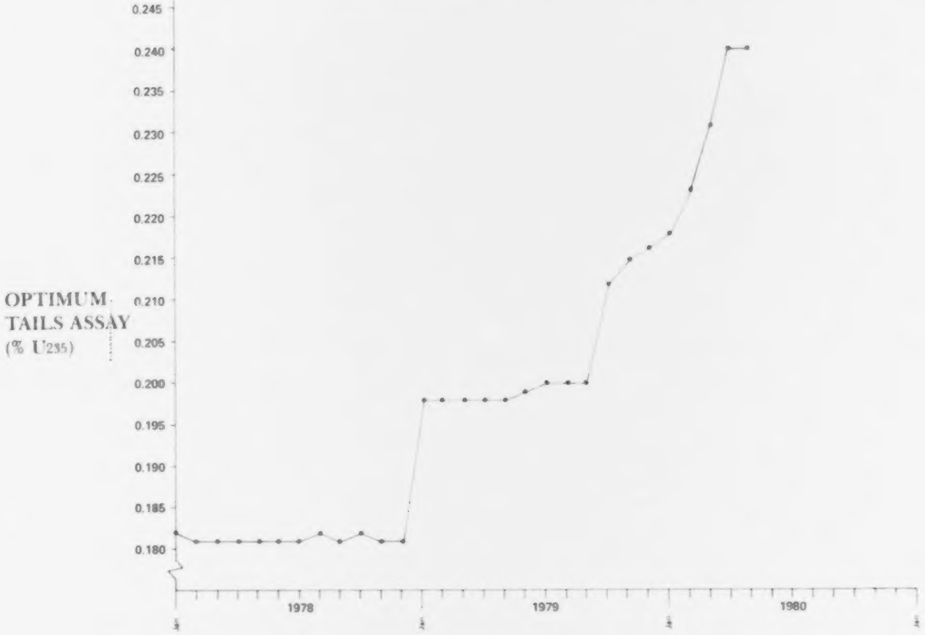
The optimum tails assay is the tails composition at which the cost of enriched uranium is lowest for given costs of separative work (SWU) and natural uranium feed. It depends only on the ratio of the cost of a kilogram of natural uranium in the form of UF_6 to the cost of a kilogram unit of separative work. The US Department of Energy (USDOE) Adjustable Fixed Commitment (AFC) enrichment contract holders have the option, within limits, to specify the transaction tails assay. The transaction tails assay for USDOE Requirements contracts is 0.2 percent U_{235}. For every one-hundredth of one percent increase in the transaction tails assay, uranium consumption increases about two percent.

TAILS ASSAY FOR MINIMUM COST OF PRODUCT*



*From Nuexco Report 138

HISTORICAL OPTIMUM TAILS ASSAY[1]



[1] Based on Exchange Value and USDOE AFC SWU price; interpolated to the nearest thousandth.

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 199)[1]	Consumer Price Index (1967 = 100)[2]	GNP Implicit Price Deflator (1972 = 100)[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]		
				Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)
Annual Avg. 1970 (5)	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971 (5)	114.1	121.3	96.02	4.12	4.15	3.97
Annual Avg. 1972 (5)	117.9	125.3	100.00	4.56	4.59	4.26
Annual Avg. 1973 (5)	125.9	133.1	105.80	4.84	4.98	4.51
Annual Avg. 1974 (5)	153.8	147.7	116.02	5.44	5.63	4.88
Annual Avg. 1975 (5)	171.5	161.2	127.15	6.13	6.24	5.39
Annual Avg. 1976 (5)	182.4	170.5	133.71	6.76	6.87	5.91
Annual Avg. 1977 (5)	195.1	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978 (5)	209.4	195.4	152.05	8.23	8.56	7.01
Annual Avg. 1979	236.3P	217.4	165.46	9.27	9.50	7.59
Feb 1979	222.5	207.1	–	8.81	9.02	7.32
Mar 1979	225.4	209.1	160.22	8.84	9.11	7.36
Apr 1979	229.0	211.5	–	9.03	9.49	7.50
May 1979	231.6	214.1	–	9.06	9.15	7.47
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9	–	9.32	9.57	7.60
Aug 1979	240.6	221.1	–	9.38	9.70	7.65
Sep 1979	244.2	223.4	167.20	9.63	9.79	7.73
Oct 1979	249.0R	225.4	–	9.67	9.87	7.82
Nov 1979	250.2	227.5	–	9.79	9.86	7.87
Dec 1979	253.1R	229.9	170.58	9.80	9.92	7.91
Jan 1980	260.3	233.2	–	9.92	10.06	7.96
Feb 1980	265.4	236.4	–	9.93	10.01	7.99
Mar 1980	268.2	239.8	174.51	9.88P	10.22P	8.00P
Apr 1980	270.7	242.5	—	–	–	8.09P

P = Preliminary   R = Revised since last month

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. All data for 1977 and beyond are adjusted to the most recent benchmark—March 1978—and are subject to revision from that point forward, with the advent of the next benchmark scheduled for publication in late 1980.

(5) Data for these years, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Nuexco Report 139.

STATISTICAL DATA

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry—All Groups (Year 1968-69 = 100.0)[1]	Weighted Average Minimum Weekly Wage Rates—Adult Males Australia Mining and Quarrying (A$)[2]
Annual Avg. 1970 (3)	101.4	59.88
Annual Avg. 1971 (3)	101.5	65.95
Annual Avg. 1972 (3)	105.6	71.26
Annual Avg. 1973 (3)	124.4	78.96
Annual Avg. 1974 (3)	141.9	108.07
Annual Avg. 1975 (3)	150.4	132.55
Annual Avg. 1976 (3)	168.4	160.93
Annual Avg. 1977 (3)	192.0	179.03
Annual Avg. 1978 (3)	215.4	190.04
Dec 1978	235.7	199.28
Jan 1979	246.3	199.79
Feb 1979	253.0	200.00
Mar 1979	264.0	201.45
Apr 1979	273.0	202.27
May 1979	287.5	203.38
Jun 1979	293.8	209.88
Jul 1979	295.8	210.49
Aug 1979	290.8	211.56
Sep 1979	300.0	212.34
Oct 1979	307.0	211.80
Nov 1979	308.0	211.12
Dec 1979	317.0	212.73
Jan 1980	337.7P	214.76P
Feb 1980	343.2P	

P = Preliminary R = Revised since last month

(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

(2) Australian Bureau of Statistics, Canberra; "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest twelve months shown are subject to revision.

(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Nuexco Report 138.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000)[1,2] (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings ($C)[3,4]		
		Metal Mining, including milling (SIC 050-059)	Primary Metal Industries, non-ferrous (SIC 296-298)	Chemicals and Chemical Products (SIC 370-379)
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Annual Avg. 1979	217.8	9.60	7.35	7.67
Jan 1979	204.8	9.19	7.14	7.29
Feb 1979	208.5	9.24	7.18	7.36
Mar 1979	210.4	9.47	7.20	7.51
Apr 1979	212.8	9.68	7.26	7.63
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3	9.37	7.34	7.73
Aug 1979	220.0	9.56	7.38	7.77
Sep 1979	223.4	9.75	7.50	7.81
Oct 1979	227.4	9.89	7.54	7.88
Nov 1979	228.1	9.97	7.61	7.91
Dec 1979	230.3R	9.93	7.51	7.89
Jan 1980	238.7R	9.96P	7.57P	7.99P
Feb 1980	240.3	10.11P	7.64P	8.07P
Mar 1980	238.5P	—	—	—

P = Preliminary   R = Revised since last month

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 4.10 of Nuexco Report 138.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 4.11 of Nuexco Report 138.

STATISTICAL DATA

REPUBLIC OF SOUTH AFRICA STATISTICS

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100, except where otherwise indicated)
Annual Avg. 1970 (3)	7.34	100.3 (4)
Annual Avg. 1971 (3)	7.88	106.4 (4)
Annual Avg. 1972 (3)	8.79	113.3 (4)
Annual Avg. 1973 (3)	10.51	124.1 (4)
Annual Avg. 1974 (3)	13.18	138.5 (4)
Annual Avg. 1975 (3)	16.71	157.2 (4)
Annual Avg. 1976 (3)	19.30	174.7 (4)
Annual Avg. 1977 (3)	23.87	194.4 (4)
Annual Avg. 1978 (3)	27.14	137.2
Annual Avg. 1979 (3)	30.18	155.3
Feb 1979	–	146.1
Mar 1979	28.60	148.6
Apr 1979	–	149.9
May 1979	–	150.6
Jun 1979	29.44	152.4
Jul 1979	–	157.9
Aug 1979	–	160.2
Sep 1979	30.71	162.1
Oct 1979	–	162.9
Nov 1979	–	163.4
Dec 1979	31.89	164.0
Jan 1980	–	165.4
Feb 1980	–	167.0
Mar 1980	33.65	168.0
Apr 1980	–	170.0

---

(1) Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly.

(2) Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Price Index for Urban Areas."

(3) Historical data for 1970 through 1979 appear on page 4.9 of Nuexco Report 140.

(4) April 1970 = 100.00

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

SUPPLY

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8) 1980	1981	1982	1983	Remarks
Uranium Available for Sale:					
1213	700				
1236					
1274	150				
1284	250				
1286	350	150	150	150	
1306		100	200	200	
1315			200	200	
1325	750				
1338	250				
1346	100				
1377	50				
1392	300				
1394	250				
1403	150				
1417	800				UF_6
1425	100				
TOTALS	4200	250	550	550	
Uranium Available for Loan:					
1175	700				UF_6
1234	700				
1354	600				UF_6
1355	600				
1428	500				
1429	500				
TOTAL	3600				

MARKET OPPORTUNITIES

DEMAND

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8)				Remarks
	1980	1981	1982	1983	
Inquiries to Purchase:					
1146		100	200	200	
1335	300				
1357		300			
1381	100	50			
1396	200				
1406	50				UF_6
1408	150				
1410		2000	2000	2000	
1427	400				
TOTALS	1200	2450	2200	2200	

Inquiries to Borrow:

1220	1000
1034	200
1348	350
1404	250
1415	600
TOTAL	2400

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NUEXCO

JULY 1980 NUMBER 143

Monthly Report on the Uranium Market

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT 143

The **Exchange Value** declined this month to $31.50 per pound U_3O_8, from $32 last month. The market continues to be very thin, and only a few small transactions closed last month. A large amount of material remains available for sale and delivery in the near-term; most of it from inventory holders. However, lower interest rates combined with declining prices have removed some of the pressure on inventory holders to sell, thus many potential sellers are holding out for prices much higher than Exchange Value. The present lack of utility buyers in the near-term market explains the absence of upward price pressure. A few sellers have been willing to reduce prices to near the bid levels of the few buyers in the market. Thus some transactions have been completed, and others are under discussion.

The **Transaction Value** declined slightly to $37.60 per pound U_3O_8, from $37.90 last month. The Transaction Value's failure to move quickly reflects the thinness of the present market. A large number of transactions closed several months ago when prices were higher, and these have dominated the Transaction Value calculation sample for the past few months. More recent, lower price transactions have been relatively small, so old, higher price transactions have remained in the sample, which by definition must include at least ten transactions totalling at least two million pounds U_3O_8.

The weakening uranium market has prompted renewed discussion of a new US import embargo. The **General** section of this Report outlines the reasons Nuexco believes that a new embargo is most unlikely.

A position paper is being circulated in the **US** Department of Energy which provides for a role for the Department in the reactivation of nuclear power in the US. The major conclusions and proposals in the paper are summarized in the **Public and Government Policy** section of this Report.

This month's *Topical Essay* is the latest in a series on various aspects of uranium marketing and procurement. It focuses on UF_6 conversion.

The *Raw Materials* section discusses the Tallahassee Creek uranium district in Colorado.

This Executive Summary may be reproduced for internal distribution.

7/80

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NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

July 1980 No. 143

MANAGING EDITOR:
JAMES E. VAUGHAN

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NUEXCO

FOREWORD

We are delighted to announce several personnel changes in the Nuexco organization. Kathryn K. Bowen has assumed the position of Manager, Uranium Marketing. Katie's duties in her new position will focus on spot market activity.

W. Scott Hickman has been appointed Manager, Business Development. Scott's new duties will involve developing new activities to supplement Nuexco's conventional business.

Kim M. Peyton has joined the Nuexco staff this month as an Associate. Kim is a recent graduate of Stanford University where she majored in journalism.

Katie Bowen

Scott Hickman

Kim Peyton

URANIUM MARKET

PUBLIC AND GOVERNMENT POLICY

In the **US,** evidence of a recognition of need for a positive nuclear power program have surfaced within the US Department of Energy (DOE). An internal DOE document which provides for a role for DOE in the reactivation of nuclear power is being circulated in the Department. Concurrence or non-concurrence of DOE Assistant Secretaries has been solicited, and the reactions have been mixed.

Conclusions and proposals in that position paper are far-reaching. The major points included:

- Need for a very different way of doing business by and between government and industry. The paper argues that patchwork solutions will always prove inadequate.
- An urgent need exists for a clear, coherent US nuclear power policy. Industry, the administration, congress and the public are confused.
- Use by DOE of *targets* rather than *forecasts* is required. That is, helping to create an end result rather than forecast an end result is necessary.
- Obstacles to progress in nuclear power are in the political arena. DOE programs are centered on the technical arena. DOE should adopt a new role by focusing on that which needs to be done. The most important problem to be overcome with nuclear power in the US is the poor political atmosphere.
- Coal and nuclear power must carry the electrical power burden for the foreseeable future. A middle ground expectation is that electrical demands for the year 2000 will require 450,000 MWe of coal generation, and 400,000 MWe of nuclear power.
- The nuclear supplier industry in the US is capable of meeting the challenge now, but may atrophy in a few years.
- Nuclear power project cycles can and should be reduced from 12 to 6.5 years.
- Regional energy centers should be a key part of the nuclear power program.

The proposed program, if it could be implemented, would have a far reaching impact on the uranium industry. Another 220 nuclear units beyond those already operating, under construction or on order would have to be completed by the year 2000. However the near-term influence on the uranium market is likely to be very small, even if the proposal were to receive Department approval. The chances of the Carter administration's trying to implement the necessary enabling legislation prior to this year's election are negligible, and the most fundamental requirements for change in the US are legislative. Congressional action is necessary to protect private investors from unexpected and uncontrollable government actions. Without such protection, there will likely be no resurgence of the nuclear power business in the US.

Even assuming that some action is taken by the administration in power after the 1980 election, the outcome will not necessarily be positive in the short-term. Public pressure to solve the energy problem is not likely to mount on Congress until more tangible effects of the problem are felt by the public. This may take some time, perhaps years. However the mere existence of a constructive attitude within DOE toward the resurgence of nuclear power, as evidenced by the surfacing of this position paper, must be considered as a positive sign.

GENERAL

The Embargo Question

The original limitation on the use of foreign-source uranium in US reactors, associated with the Private Ownership Act of 1964, has been phased out to the point of commercial insignificance. However, the recent decline in the near-term market price of uranium has stimulated renewed discussion of a new US import embargo.

The embargo question impacts on all segments of the uranium industry. As might be expected, calls for its reimposition have been raised by a few US producers. Some producers are concerned that low-cost foreign production will supplant higher-cost US production. In these discussions, potential US dependence of foreign uranium supply is likened to OPEC and the oil situation.

Many US utilities, on the other hand, are interested in obtaining some portion of their supply from non-US sources. The desire by US buyers to purchase off-shore is closely linked to expectations of prices below what they would have to pay for US supply. Renewed talk of an embargo raises utility concerns about contract terms that might require taking and paying for uranium that could not be used. Some US utilities have made this point in discussions with Australian officials. The utilities are seeking assurance that they would not have to take what they could not use.

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The embargo question is of special concern to governments of exporting nations. Although US uranium consumption is declining as a percentage of the world total, it is and will remain for the foreseeable future the world's largest market. Access to the US market is important to Canada's Saskatchewan sellers as well as Australia's fledgling industry.

The position of the US government on the embargo question is less clear. USDOE has discussed the matter with the Australian government and presumably the governments of other uranium exporting nations. Although the specific content of these discussions is not known, DOE's position, based on its historic interests, is the long-range national security interest of the US in a viable domestic uranium industry. The immediate threat is the cost leadership of non-US producers, and its attendant negative impact on the US production industry.

Like DOE, US utilities wish to maintain a healthy US uranium industry. But they find it difficult to ignore a potential price advantage and are likely to opt for non-US supply if such price advantages are in fact offered. While imports could be limited, or cut off by embargo, by tariff, by informal government-to-government agreements or some combination thereof, such actions are viewed by Nuexco as unlikely. The reasons for this are as follows:

Political problems. A number of important US uranium producers and potential producers are also important international oil companies (e.g. Exxon, Kerr-McGee, Getty, Sohio, Chevron, Arco, Gulf, Conoco, Mobil). An import embargo (which can be expected to increase US uranium prices relative to the rest of the world) would be viewed as benefiting these oil companies at a time when most US politicians would rather have their constituents believe that oil companies are the victims, rather than the beneficiaries, of their actions. Further, there is a substantial political risk in any action which may be viewed by the public in resulting in higher energy prices.

Industry profile. Uranium industry problems will not cause overall business problems for most producing companies. About 45 percent of US uranium is produced by oil companies and about 40 percent by other large organizations in which uranium is a relatively minor activity.

Lack of political clout. About three-fourths of current uranium production in the US comes from New Mexico and Wyoming whose combined population is less than one percent of the US total. Therefore, at the federal level, the political clout of the uranium-producing states is low. Only a small number of voters are affected. Further, uranium is a small business viewed in the context of the total US economy. US production for 1980 is estimated to total about 36 million pounds U_3O_8. If all of this production were sold at today's Exchange Value, the annual industry volume would be only a little more than one billion dollars. The oil industry, by comparison, is well over $100 billion in annual sales. The US uranium production industry is probably too small to receive sustained political attention.

Small balance of payments effect. US uranium consumption is expected to level off at 45 to 50 million pounds U_3O_8 per year in the mid-1980's. At that time, US production is presently expected to yield 25 to 30 million pounds U_3O_8 annually (see Nuexco Report 141). Even if no additional US production comes on line in this period, and net US imports reach 20 to 25 million pounds U_3O_8 annually, the net balance of payments deficit would still be on the order of only one percent of the current US balance of payments deficit for petroleum.

Complicated Foreign Relations. From a practical standpoint, only two exporting nations would be affected, Canada and Australia. The other major producers, South Africa, Namibia and Niger, can be expected to supply only small amounts to the US. Embargoing uranium would likely lead to linkages in negotiations with Canada for increased gas and oil imports into the US. Unilateral imposition of a uranium embargo would not be the simple move it may appear to be on the surface. Hearings prior to legislative action would bring to the surface all such ramifications.

Complexity. Defining what would be embargoed, to what extent, the effective time frame and applicable procedures would require time. Congressional investigations are to be expected prior to government action. A number of facets would be considered. Would present-type restrictions upon utility use merely be extended? Would import measurements apply to gross or net imports? Would demand growth alter allowable quotas? Would trigger mechanisms related to price, volume, etc., be utilized? In other words, the due process required for quality legislation would

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take time. Producers, buyers, consumers, environmentalists, free trade advocates, foreign affairs experts, and numerous others would present points of view. The problem of moderate foreign competition in uranium may not be viewed as sufficient to warrant investment of government and legislative time to the extent required.

Favorable export/import balance. The US currently exports slightly more than it imports. It is not clear how exports would be affected by restrictions on imports. A two-tier price situation might develop that would not necessarily be advantageous to the US producers who wish to sell for export.

No analogy to earlier embargo. The earlier US import embargo was designed to assist the transition from a government-dominated military procurement market to a developing commercial market. No analogy to that situation currently exists.

Immediate problem is not foreign competition. The current dominant forces affecting US producers derive from lower than expected US consumption. Most of that reduction is caused by nuclear power plant delays which, for the most part, relate to licensing. The most effective—and probably the only significantly effective—action the US government could take to improve near-term US uranium market conditions would consist of measures to bring plants on line as early as possible.

OPEC Analogy not applicable. The suggestion that importing of uranium would place the United States in the same position as it is with OPEC vis a vis oil does not stand up under scrutiny. The US does not have the current capability to pump as much oil as it consumes. A cut off in supply or an increase in the price of oil therefore will have an immediate and sharp impact. The situation with uranium is much different. Production capacity exceeds consumption. Uranium ore reserves in the US are large, and U_3O_8 inventories, both public and private, combined with the nature of nuclear fuel cycle will provide adequate reaction time in the event of either a supply cut-off or OPEC-like price behavior on the part of uranium exporting countries.

In summary, the US uranium industry is relatively small; providing import embargo protection appears to be so unrewarding politically as to make it most unlikely even in the face of anticipated cutbacks in US production and the corresponding increases in US net imports.

Coincident with industry concern about a US import embargo, there appears to be some concern among industry participants that the US may, at some time in the future, place an embargo on the export of uranium of US origin. Two conditions, in particular, appear to prompt that concern. First is the belief that exporting would be viewed unfavorably if the US is importing uranium to meet its domestic requirements. Second is the general uncertainty caused by US non-proliferation policies. There are several reasons, however, why it is also unlikely that an export embargo will be implemented.

US non-proliferation objectives. US non-proliferation policy under the Carter Administration was founded on the assumption that granting or withholding of nuclear fuel could induce the conformance of overseas governments with US objectives. This assumption has proved to be inaccurate. The result of unilateral US policy actions have served to increase the interest of non-US users in geographical diversification of supply. An embargo of US-origin U_3O_8 could only further erode US influence.

Free trade favored. US government policies generally favor free trade, and international negotiations usually aim to reduce trade barriers. An export embargo would be inconsistent with those aims. If the US becomes dependent on overseas uranium for part of its requirements, reliability of supply will become more important to US users. Restricting US exports while simultaneously encouraging exports by others would be contradictory.

US security of supply. An export embargo would not appear necessary from a national security-of-supply standpoint. As discussed in Nuexco Report 142, US utilities currently hold inventories equal to about three times annual US consumption. In addition, the US government's strategic stockpile represents several years of US U_3O_8 consumption at the current rate. Therefore, any risk to US security of supply implicit in free trade in uranium would be mitigated by these large stockpiles, since any boycott of the US by uranium-producing nations would clearly not disrupt US electricity production.

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US not a big exporter. Nuexco's estimate of current US export and import commitments for the period 1979-1990 are set forth in Table 1. Although exports in 1979 approached 8 million pounds U_3O_8, they were offset by 6 million pounds of imports. The annual net balance of export-import commitments as seen today does not exceed 2 million pounds in either direction during any year in the period. The balance can be expected to shift towards the import side by the mid-1980's. It is not likely that the total of new export commitments will be large enough to be of true political or economic significance in the US. Consequently, there will be little political driving force for the US to enact an export embargo on uranium.

Table 1

US IMPORT-EXPORT BALANCE[1]
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
IMPORTS												
Annual	6.1	5.6	6.6	6.8	5.5	4.9	2.1	2.0	2.0	2.0	2.0	2.0
Cumulative	6.1	11.7	18.3	25.1	30.6	35.5	37.6	39.6	41.6	43.6	45.6	47.6
EXPORTS												
Annual	7.9	7.5	6.3	5.3	4.3	3.2	2.0	1.4	1.4	1.4	1.0	0.9
Cumulative	7.9	15.4	21.7	27.0	31.3	34.5	36.5	37.9	39.3	40.7	41.7	42.6
NET IMPORTS (EXPORTS)												
Annual	(1.8)	(1.9)	0.3	1.5	1.2	1.7	0.1	0.6	0.6	0.6	1.0	1.1
Cumulative	(1.8)	(3.7)	(3.4)	(1.9)	(0.7)	1.0	1.1	1.7	2.3	2.9	3.9	5.0

[1] Includes existing contracts only. Does not include contracts currently under litigation

AUSTRALIA

As noted in Nuexco Report 142, the negotiations leading to the formation of Energy Resources of Australia (ERA) continue to move forward. It is reported that German interests will take up the five percent share declined by the British. Thus, the ownership breakdown of ERA as now contemplated is:

Peko-Wallsend	30.5%
Electrolytic Zinc	30.5%
German Interests	15%
Japanese Interests	10%
Australian Public Float	14%

Reports that a long-term agreement between Ranger and a US utility would be concluded during May 1980, proved premature. Reasons for the delay are not known definitely.

Apparently the proposed obligation of the German and Japanese equity owners is to accept about three percent of annual output for each one percent of equity. Thus, assuming annual output of 6.6 million pounds U_3O_8, this amounts to 200,000 pounds U_3O_8 for each one percent of equity. The Japanese interests would take two million pounds annually and the German interests three million pounds, leaving only 1.6 million pounds to be sold by Ranger to other customers.

However, pre-existing commitments to Japanese utilities (made in the early 1970's), the repayment of loans from the Australian government, and the recent contract with Korea will account for much of the balance of production. The importance of successfully completing the formation of ERA becomes apparent when examined in these terms. If ERA is structured as presently planned, the output of Ranger will be essentially committed from the standpoint of its Australian owners. If ERA were not to go forward, a substantial marketing effort would remain to be accomplished.

Queensland Mines' Narbarlek production facility came on stream early in June, and is already operating at full capacity. Thus, the first increment of

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Australia's new wave of production has been launched. Discovered in 1970, Nabarlek required a full nine years to obtain its various approvals, and only one year to build the mill and commence operations.

CANADA

The predictable theme at the meeting of the Canadian Nuclear Association (CNA) last month was the importance of increasing nuclear generating capacity to provide adequate electrical energy to continue the nation's economic growth. The corollary of using nuclear power for electrical generation is to allow conservation of oil for the things oil alone can do.

An important point brought out at the CNA meeting is that electrical resistance space heating is already cheaper than oil when the electricity is produced by nuclear power. The price of nuclear generated electricity in the Toronto area is currently C$0.023 per kilowatt hour delivered to the residence. Thus heating a typical one thousand square foot Toronto home by electrical resistance heating would cost C$445 annually, if the electricity were generated by nuclear power. The equivalent cost of heating that home with fuel oil on the basis of C$36.00 per barrel of oil (roughly equivalent to US$30.00) is C$1,350 annually.

Of course all electricity produced in the Toronto area is not nuclear, and the average cost of fuel oil in Canada is not yet equal to the average OPEC price. However the above comparison does indicate a trend. In most of the world, including many parts of North America, electrical resistance space heating from nuclear electricity is less expensive than oil heat.

Esso Minerals Canada and its partners Bow Valley Industries and Numac Oil & Gas are continuing studies on the proposed mining and milling complex at Midwest Lake in northern Saskatchewan. Production could begin as early as 1986. The cost of establishing facilities capable of producing 4.4 million pounds U_3O_8 per year is now estimated at C$400 million dollars. Indicated reserves at Midwest Lake are 75 to 80 million pounds U_3O_8; 60 million pounds of nickel and seven million pounds cobalt.

Technical hearings concerning licensing of production at the Key Lake deposit in northern Saskatchewan began last month, and are expected to continue through July. A final report is likely to be issued in September of this year.

FAR EAST

Reflecting less optimistic economic projections, **Korea's** nuclear power program is facing its first substantial delay. While the first seven nuclear units (six Westinghouse PWRs and one CANDU reactor) remain on previously announced schedules, units 9, 10, 11 and 12 will be delayed 3 months, 3 months, 6 months and 12 months respectively. The revised schedule is shown below.

	Completion Date	
Unit	**Previous**	**Revised**
Kori 1	Operating	
Wolsung 1	April 1980	Same
Kori 2	December 1983	Same
Nuclear 5	September 1984	Same
Nuclear 6	September 1985	Same
Nuclear 7	March 1986	Same
Nuclear 8	March 1987	Same
Nuclear 9	December 1987	March 1988
Nuclear 10	December 1988	March 1989
Nuclear 11	March 1989	June 1990
Nuclear 12	December 1989	Dec 1990

Korea's previously announced goal of some 40 reactors in operation by the year 2000 has been viewed for some time as very optimistic. The recent revision is no doubt the first step in establishing a more realistic target.

Despite substantial current inventories and a forward contract position second to no other consumer nation, it now seems certain that a **Japanese** group will purchase ten percent of the equity in Energy Resources of Australia (ERA), the company that will own Ranger. As noted above, this will amount to two million pounds of U_3O_8 annually, once Ranger is in full production. The ten percent Japanese interest will be divided as follows: Kansai 50 percent, Kyushu 25 percent, Shikoku 15 percent, and the trading company C. Itoh, 10 percent. C. Itoh can be expected to sell its share of the output to one of the other Japanese utilities.

Sensitivity in Japan to security of long-term supply was further demonstrated recently by the decision to spend $6 million to construct a prototype plant to recover uranium from sea water. Scheduled for completion in three years, the plant will have a design capacity of only about 25 pounds U_3O_8 annually.

The next step after the prototype plant is apparently the construction of a demonstration plant with an annual capacity in the range of 40,000 to 60,000 pounds. The final step in the plan would involve construction, beginning about 1990, of a commercial facility with an annual capacity in the range of 600,000 to 2,000,000 pounds U_3O_8.

The projected cost of uranium recovery from sea water is so high that it might argue against such an undertaking, and suggest that funds spent on the effort might better be spent acquiring additional uranium inventory. However, in Japan's case, short-term economic considerations tend to be outweighed by desires to increase security of supply in the long term.

UNITED STATES

President Carter exercised his authority under the 1978 US Nuclear Non-proliferation Act (NNPA) to allow the export of enriched uranium for use in India's Tarapur plant. It is expected, however, that factions in both the House and Senate will attempt to override the decision before the 60 legislative days they have to do so expire.

A new state initiative on uranium is on the South Dakota ballot. If passed, it would require a majority vote of all South Dakotans before any uranium mining project would be permitted to begin operations. Currently, three projects in the state could be affected.

Despite the current uranium market conditions, there appears to be no slowdown in uranium development in the state of Texas. US and overseas companies are actively exploring, acquiring leases, and developing in situ leach operations in the state.

In the first half of 1980, reactor delays and deferrals have reduced uranium consumption in the US by more than 29 reactor-years from previous Nuexco estimates. In addition, several plants which are in the early stages of construction are seriously being considered for conversion to coal-fired units.

In its June 11, 1980 decision regarding the aborted Occidental-Bokum deal involving Long Island Lighting company (LILCO) the New York Public Service Commission appears to have reversed its previous position, decided in 1978, regarding captive uranium production of New York utilities. In the prior decision, involving Niagara Mohawk Power Corporation, the utility was required to pass through savings to rate payers, but not losses, from its uranium venture. In the recent deal involving LILCO, the utility would not have been required to pass through savings from its uranium venture to its rate payers.

TRANSACTIONS

Four sales and one loan were concluded this month, but the quantity involved in each transaction was relatively small. The loan was between a European utility which loaned material to a European nuclear contractor. The use charge rate was consistent with the Nuexco Loan Use Charge Rate.

Three of the four uranium sales were for quantities under 50,000 lbs. U_3O_8 equivalent. One of these involved a US utility selling UF_6 to another US utility for immediate delivery. The second entailed the sale of enriched uranium by a US utility to a Canadian nuclear contractor. The third small deal was between a US producer and another US producer. The larger transaction was a sale from a US nuclear contractor to a US producer. The price in each sale was fixed, and all deliveries are scheduled to occur in 1980.

PRICING

The **Exchange Value** declined slightly this month to $31.50, as a few sellers were willing to decrease prices somewhat in an effort to complete transactions. Substantial quantities of material are available for near-term delivery, however the sellers of most of it have been seeking prices well above Exchange Value. Many of the utility sellers that were aggressively attempting to market earlier in the year have recently been reluctant to cut prices. Thus most of the utility material that was for sale remains unsold. With interest rates lower and prices declining, selling pressure appears to be lower for the moment. Nevertheless the material still overhangs the market.

Inquiries to sell uranium for 1980 delivery total about 4.1 million pounds U_3O_8. Of that total, about 40 percent is being offered by uranium producers. Inquiries to purchase for 1980 delivery now total about 750,000 pounds U_3O_8, of which about 40 percent is being sought by utility buyers. It is the lack of utility buyers requiring material for near-term delivery that is mainly responsible for the absence of any upward price pressure on the market.

A few relatively small transactions closed last month, all for near-term delivery. While many sellers are holding out for higher prices, a few have indicated willingness to reduce prices somewhat in order to complete near-term sales. However the market continues to be very thin at this time. For the most part there is a wide gap between bid and offered prices.

Those buyers that received offers during the last 60 days in response to formal invitations for intermediate-term quotations continue to evaluate the responses. There is an apparent and understandable lack of urgency as prices continue to decline. As a consequence, no transactions are now being concluded for other than spot and near-term delivery.

The **Transaction Value** decreased only slightly this month to $37.60 per pound U_3O_8. As in other recent months the Transaction Value was largely influenced by transactions which closed several months ago. This month's sample extended over five months, involving 17 transactions totaling 4.1 million pounds U_3O_8. A large number of these transactions, involving a total of about three million pounds U_3O_8, closed in February 1980 (and were reported in March, five months ago). At that time, prices were generally much higher than today.

One objective in defining the Transaction Value was to maintain a certain amount of inertia in it. The experience of the past few months however, may indicate that the definition provides excessive inertia in a thin market. For example, if the Transaction Value had been calculated using only the past four months (thus omiting transactions reported in March) without regard to the requirement for at least ten transactions and at least two million pounds U_3O_8, the current Transaction Value would have been $30.70 per pound U_3O_8.

CONVERSION

As indicated in previous Nuexco Reports (e.g. Report 138) a secondary market for uranium conversion services is developing. A few transactions have already taken place in this market. In the secondary market, the conversion contractor is not involved directly. Usually the transaction takes the form of a swap whereby UF_6 is exchanged for an equivalent amount of concentrates, plus a cash payment to cover the conversion. The cash payment associated with the swap is thus the conversion price in the secondary market.

The swap involves the following steps:

1. The seller of the conversion services (seller) instructs its conversion contractor (converter) to make UF_6 deliveries as required by the buyer of the conversion services (buyer).
2. The buyer delivers an equivalent amount of concentrates to the seller's account at a location specified by the seller.
3. After completion of the swap, the seller invoices the buyer for the agreed conversion price.

From the standpoint of the seller of the conversion services, the transaction is in effect a "deconversion" of UF_6 (i.e. UF_6 to uranium concentrates).

The *Market Opportunities* section of this Report contains a tabulation of conversion now available for sale, and inquiries to purchase conversion services. The opportunities listed are limited solely to the secondary conversion market. Nuexco's judgment as to the price at which transactions for conversion services in the secondary market could be concluded as of June 30, 1980, based on past transactions and current supply and demand for conversion services, is $1.50 per pound U in UF_6.

TOPICAL ESSAY

MARKETING AND PROCUREMENT: UF_6 CONVERSION

Introduction

Chemical converison of natural uranium concentrates into the form of uranium hexafluoride (UF_6) is a necessary part of the light water reactor fuel cycle. This is because uranium in the form of UF_6 is the required feed for all existing commercial enrichment facilities. Thus conversion is an integral component in both the marketing and procurement side of the natural uranium market. The conversion plant is often the delivery location under uranium supply contracts, or it is at least the ultimate destination upon shipment by the seller. Usually the seller of the uranium concentrates is paid on the basis of the weighing, sampling and analysis performed after arrival at the conversion plant.

In addition to their intended function, the conversion contractors' facilities have largely served as the physical "surge tank" for the industry's natural uranium inventories. This was not by design, but given the nature of most uranium supply contracts, which usually call for delivery at or shipment to the converter, and given that final payment to the producer is based on weighing and analysis done at the conversion plant, it is not surprising that so much of the inventory is at conversion plants. It is estimated that about 72 percent of the current US-owned commercial inventory of natural uranium is located at the two US conversion plants, with most of the balance at USDOE. Two commercial storage facilities are also licensed in the US, but significant amounts of US-owned inventory have not yet been moved into these facilities.

Weighing, Sampling and Assaying of Concentrates

When natural uranium concentrates arrive at the conversion plant, it is first necessary to determine how much material has been delivered, and whether the material is acceptable for conversion. Thus the first thing that happens to the concentrates is weighing, sampling and moisture determination. Later the samples which were taken are sent to a laboratories where chemical analyses are performed. The following paragraphs describe this process.

Natural uranium concentrates are normally shipped in open head 55 gallon steel drums. Figure 1 is an overview of a concentrates storage area at a US conversion facility. The extent of the uranium inventory physically located at the facility is apparent from this photograph. Figure 2 shows a forklift positioning a lot for weighing and sampling. Individual drums move on a conveyor to a scale where the gross weight of each drum is recorded. After weighing, an operator removes the lid and a drum dumper, shown in Figure 3, inverts the drum, and the concentrates are dumped into a hopper below the dumper. A portion of the stream of concentrates falling into the hopper are cut out to form a sample. (This is the *falling stream* method of sampling.) After the drum is dumped the residual concentrates are removed from it by vacuuming (Figure 4). After dumping and vacuuming, the lids are replaced on the empty drums, and the tare weight of each drum is recorded, thus furnishing the net weight of concentrates in each drum. When weighing and sampling are completed, the concentrates are retransferred from the hopper to the empty drums, as shown in Figure 5.

The total of all sample cuts taken from the drums of a given lot are further split to acquire the amount necessary for the *lot sample*. Moisture determination is then made in the on-site laboratory and the *sample jars* are prepared from the lot sample. Figure 6 shows a lab technician preparing the lot sample for moisture determination of the lot and for obtaining the required number of sample jars. Usually six sample jars are prepared for each lot. Two are sent to the uranium producer and two are sent to the converter for analysis and assay exchange. Two are retained for later umpire use, if necessary. The analysis of the sample jars along with the net weights are used to determine the quantity and properties of the lot.

The conversion contract contains provisions which govern the procedure for weighing, sampling, assaying, moisture determination, and umpire analysis. The purpose is to allow for simple and orderly agreement among the producer, user and converter as to the quantity of uranium delivered and whether the concentrates meet specifications. If the concentrates meet specifications for acceptance, the converter credits the storage account of the producer, or the conversion account of the user, as the case may be, for the agreed upon quantity of uranium in the lot. If the properties of the lot are such that any surcharges are required, these are usually paid directly by the producer to the converter.

TOPICAL ESSAY

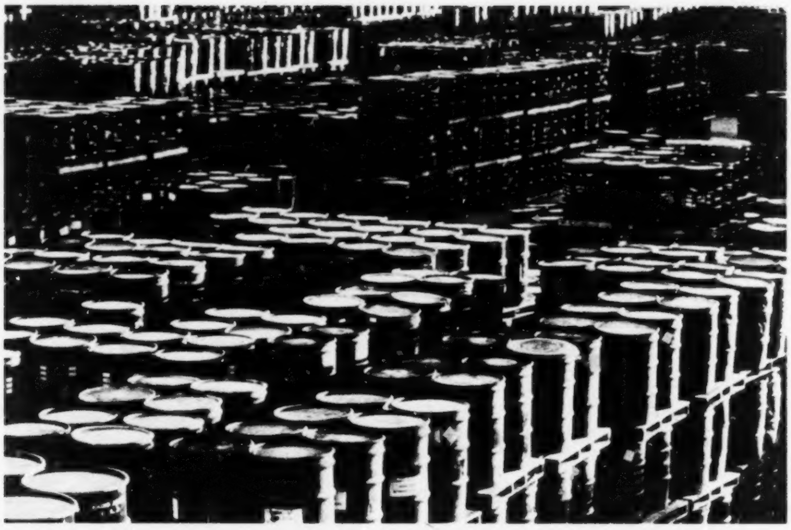


Figure 1
OVERVIEW OF CONCENTRATES STORAGE AREA AT A US CONVERSION FACILITY.

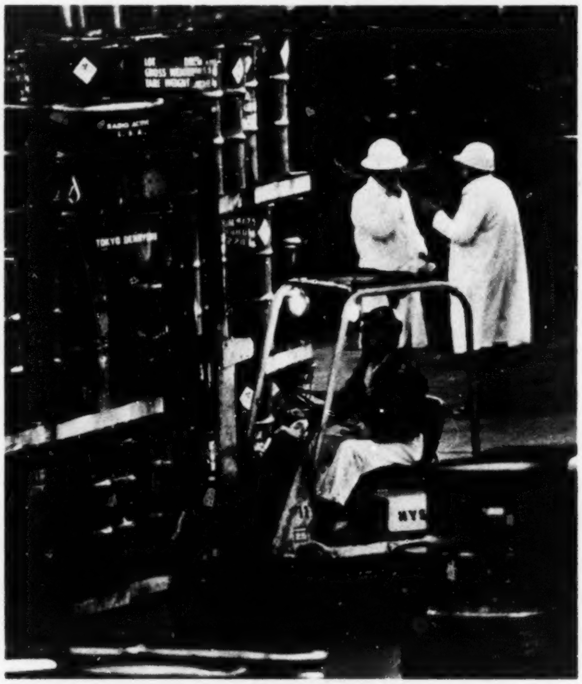

TOKYO DENRYOKU

Figure 2
MOVING CONCENTRATES INTO THE WEIGHING AND SAMPLING PLANT ADJACENT TO THE CONVERSION FACILITY.

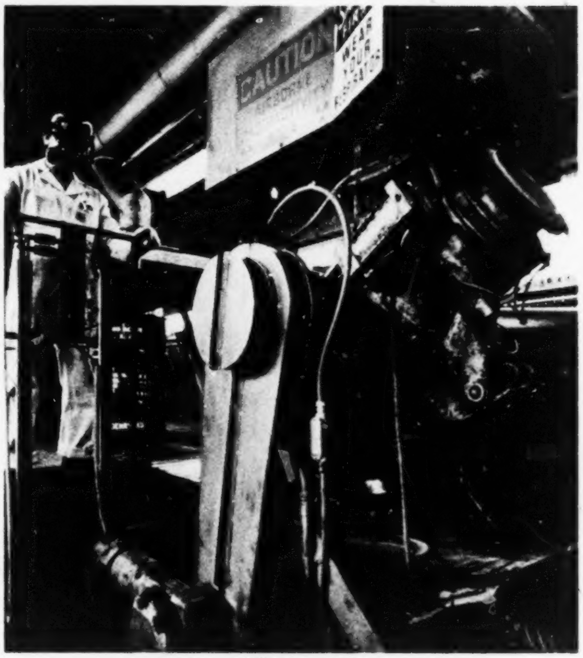

CAUTION
WEAR YOUR RESPIRATOR

Figure 3
UPENDING AND EMPTYING OF DRUMS AFTER GROSS WEIGHING. SAMPLING IS ACCOMPLISHED AS MATERIAL ENTERS THE HOPPER BELOW.

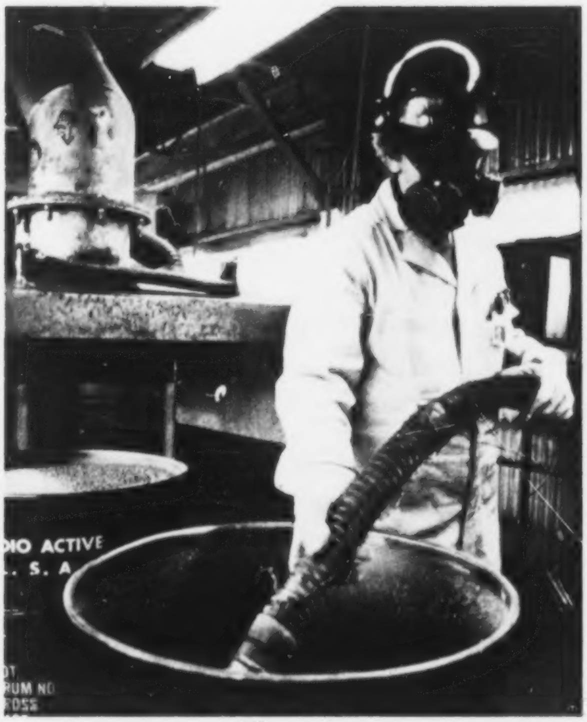


Figure 4
VACUUMING RESIDUAL CONCENTRATES FROM EMPTY DRUMS.

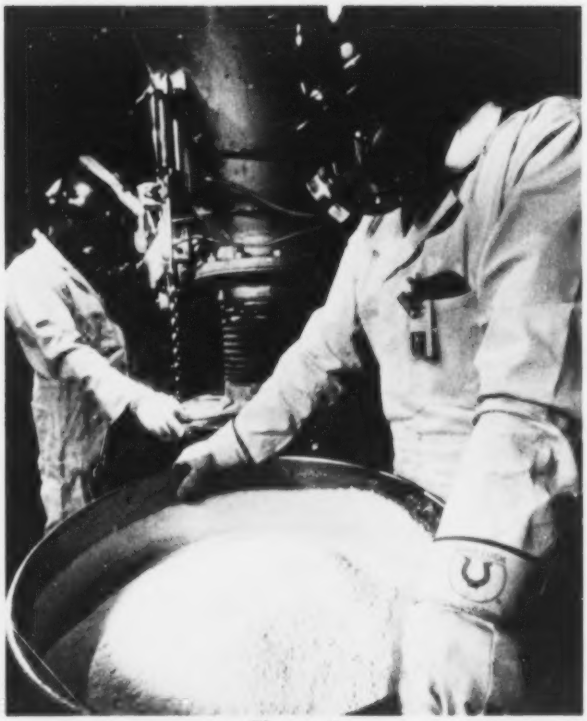


Figure 5
REFILLING DRUMS AFTER TARE WEIGHING.

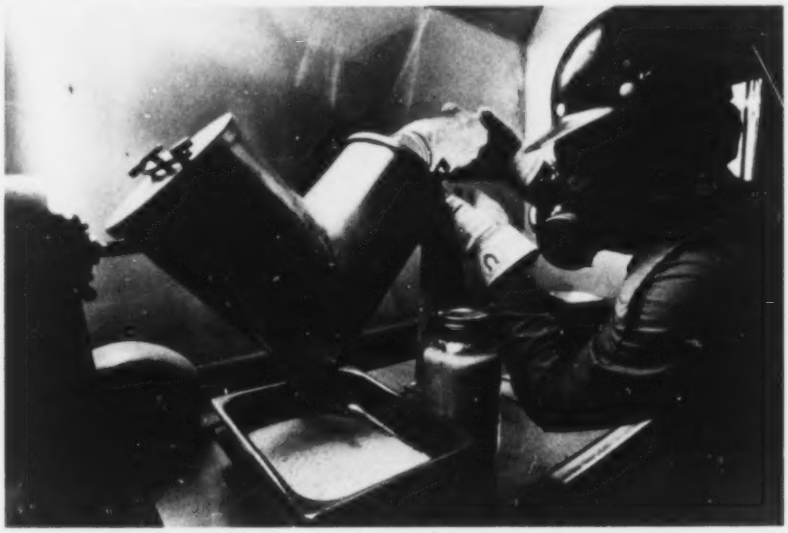


Figure 6
MOISTURE DETERMINATION AND SAMPLE PREPARATION.

TOPICAL ESSAY

The Conversion Contract

The contract between the user and the conversion contractor is of course aimed principally at the chemical conversion of natural uranium concentrates into UF_6. There are a number of other aspects of the contract, however, which often become important during the administration of the contract.

Title and risk of loss: Risk of loss in the uranium usually passes to the conversion contractor upon delivery of the concentrates, and remains with the converter until delivery of the UF_6. That is, the converter has risk of loss while it has possession. Most conversion contracts specify, however, that the user will retain title to the uranium at all times during which it is in the possession of the converter. While this requirement may seem innocuous on its face, it has often become a problem when a user has desired to sell or lend uranium while it was physically located at a conversion plant. The conversion contractor has sometimes held that the user does not have the contractual right to sell or lend material located at the facility under a conversion contract, due to the presence of the contract clause regarding the user's retaining title. Others have expressed the opinion, however, that the clause on title is intended to apply only as between the converter and the user, and is in no way intended to impede the free marketability of the material while it is in the possession of the converter.

Comingling and right to preproduce: Most conversion contracts contain a provision which allow the converter to comingle the user's uranium with other uranium in the plant, and to preproduce UF_6 at any time after acceptance by the converter of the user's concentrates. This provision is intended to allow the converter to operate its plant in a relatively continuous and therefore efficient manner. One result of this provision is that, even though the user maintains title to the material, it does so in the form of a bookkeeping entry. That is, there is no specific material physically identified to the user's contract until such time as delivery of UF_6 is actually made. This feature, present in most conversion contracts, has also been an obstacle at times when users desire to sell or lend material located at a conversion plant. Since there is no material physically identified to the contract, the user must depend on the conversion contractor to make an accounting transfer from that of the user to that of the buyer or borrower. This requires both that the converter actively cooperate in the sale or loan transaction and that the buyer or borrower have an agreement with the converter under which the material purchased or borrowed can be received.

Some conversion contracts do not grant the converter the right to comingle and preproduce. Under such contracts, the user's material is physically segregated and remains identified to the user's contract until it enters the conversion pipeline.

Book transfers: Many uranium producers have agreements in effect with conversion contractors under which the producer can deliver concentrates to the converter and retain title to the material. Under these agreements, usually called *storage agreements*, the producer can deliver the material, have it weighed, sampled and assayed, and reach agreement with the converter on *final pounds* of material delivered. Thereafter, the producer can advise the converter to make a book transfer of final pounds to its customer's conversion account.

Delivery of UF_6: The conversion contract normally specifies that UF_6 is to be delivered to the facilities of a uranium enrichment contractor. The UF_6 will usually have to meet a set of UF_6 physical specifications. The converter will normally provide UF_6 cylinders in the case of a standard delivery to an enrichment plant.

Storage: Traditionally, when the conversion contract has provided the converter with the right to comingle and preproduce, the contract has been silent on storage charges for uranium in the form of concentrates. However there are now indications of a movement by the converters toward restricting unlimited storage of concentrates. The reasons for this include the liability and property insurance considerations of the large amounts of material now in the possession of the converter.

When a UF_6 delivery is called for under the conversion contract, and the user does not have a corresponding requirement for a natural UF_6 delivery at the enrichment plant, some accommodation must be made between the user and the converter. This will take the form of either a contract modification, or an arrangement to store the UF_6, on the converter's site or elsewhere. (Sometimes the conversion contract will include a limited duration of UF_6 storage by the converter.) If storage is arranged at a site other than that of the converter, a problem arises in that the usual delivery point under the conversion contract is an enrichment plant. Therefore alternate delivery arrangements must be agreed to by the converter and the user. Also quantities and properties of UF_6 delivered by the converter are normally determined in connection with weights and assays made by the enrichment contractor. If third party storage is arranged, some accommodation needs to be made between the user and the converter on the determination of UF_6 weight and assay and the converter's warranty of specifications at the time of ultimate delivery of the UF_6 for enrichment. Finally, regardless of where UF_6 is stored, lease or purchase of UF_6 storage cylinders must be arranged.

COMMENTARY

DIABLO CANYON

The fact that the Pacific Gas and Electric Company has been granted substantial rate increases during 1980 has not escaped the attention of the news media in California. However, one of the principal contributing factors making these rate increases necessary has apparently not yet been detected by reporters. It is namely the continuing delay in the operation of the Diablo Canyon nuclear power plant.

PG&E's Diablo Canyon plant, located near San Luis Obispo, consists of two 1150 MWe PWR units. Both units are essentially complete and ready to begin startup operations. However, startup has been delayed as the result of the licensing logjam at the NRC, and continued opposition on the state level by the administration of California Governor Jerry Brown. If the Diablo Canyon plant were operating, PG&E could avoid burning about 20 million barrels of oil per year. At an assumed price of $30 per barrel (recent spot prices have been much higher), the annual cost of burning that oil is $600 million.

In contrast, the annual nuclear fuel cycle cost for the Diablo Canyon plant to produce an equivalent amount of electrical power would be $80 million. Thus PG&E and its rate payers would save at least $520 million per year in fuel cost if Diablo Canyon were allowed to operate. The PG&E service area includes a population of nine million people. Continued delay in Diablo Canyon startup in effect costs each PG&E rate payer $58 per year, or $232 annually for a family of four.

In addition to the fuel cost *now* being paid by the consumer, the cost of the idle plants will also eventually have to be passed on to the rate payer. The annual financing charges (in the hundreds of millions of dollars) for the idle plant are currently not in rate base. But these financing charges are accrued, and they will ultimately be capitalized and paid by future consumers of electricity.

Normally the news media is quick to discover and expose bilking of the consumer, especially when it involves such large amounts of money. Its failure to do so in the case of Diablo Canyon is so glaring that is is difficult to understand how it could happen.

TALLAHASSEE CREEK URANIUM DISTRICT

Introduction

A number of small uranium occurrences were discovered in the Tallahassee Creek area of Colorado during the early 1950's. However, the area did not attain "district status" until 1977 when Cyprus Mines Corporation announced that it had discovered about 30 million pounds U_3O_8 contained in two ore deposits on Middle Tallahassee Creek. At the time the discoveries were announced, they represented one of the more significant developments in the US uranium industry in several years.

A new surge of exploration activity followed the Cyprus announcement, and by early 1978 between 15 and 20 companies had acquired about one million acres in the district for the purpose of uranium exploration.

Tallahassee Creek is located about 20 miles northwest of Canon City in Fremont County, Colorado. The principal area of interest to exploration groups is a sedimentary sequence of Tertiary formations filling a structural trough referred to as Echo Park Graben. The trough separates the uranium district from South Park Basin, the southernmost of three structural basins situated between the Front Range of the Rocky Mountains to the east, and the Park Range and Sawatch Range to the west. Numerous uranium occurrences have been discovered throughout the intermontane basin areas, however past production and presently existing ore reserves are primarily limited to the Tallahassee Creek district. The deposits discovered by Cyprus represent the largest known occurrence of uranium in sedimentary rocks in the Colorado Front Range region.

Exploration and Development

Uranium was first discovered in the Tallahassee Creek area in 1954 by prospectors using hand-held radiometric detection instruments. The first discoveries were located on radiometric anomalies in soil cover, rather than rock outcropings. Subsequent trenching revealed uranium mineralization within a few feet of the surface. A prospecting rush followed, which resulted in the location of a number of anomalies. At least 15 small ore deposits were soon discovered at depths to 100 feet below the surface. The principal ore minerals in the deposits were uraninite and autunite, associated primarily with carbonaceous material, pyrite and calcium carbonate.

Almost all the mineralization discovered in the 1950's occurred in two depositional environments within the upper portion of the Tallahassee Creek Conglomerate of Oligocene-Miocene Age. In the upper 30 feet of the formation, the ore zones were found as irregular accumulations in a fine to coarse conglomerate consisting of rhyolite, andesite and Precambrian granitic boulders, with a fine matrix of volcanic ash, tuff and claystone. Rock alteration was common, and in this oxidizing environment, the ore minerals present consisted of autunite and uraninite.

The deeper ore deposits were tabular and usually elongated in the direction of sedimentary trends. The deposits were found near the base of a tuffaceous sandstone unit, which is in unconformable contact with the lower Echo Park Formation and/or Precambrian rocks, both of which had been subjected to extensive erosion and block faulting. Uranium mineralization is closely assocated with tuffaceous zones where the formation is at maximum thickness due to channel-filling of pre-Tallahassee Creek Conglomerate topography. The uranium-bearing host formation is the Ash Fall unit of the Tallahassee Creek Conglomerate. At least two of the small uranium deposits were found in Echo Park Formation. The predominant ore mineral was uraninite with minor amounts of autunite, and the accessory minerals, pyrite, hematite and limonite. Carbonaceous material is an important constituent in the host rock. It is considered to be the primary chemical control relating to localization of uranium mineralization.

The largest of the ore deposits contained about 25,000 tons of ore; the smaller deposits contained less than 1,000 tons. Property development and mining occurred principally during the period from 1957 through 1960, but continued sporadically through 1972. Total production from the district through 1972 was about 96,000 tons of ore at an average grade of 0.25 percent U_3O_8. All mining was by open pit methods. The ore was shipped to processing mills at Canon City and Gunnison, Colorado.

The first deep exploration drilling in the district was initiated in 1968. The main exploration target was the lower portion of the Echo Park Formation which is in unconformable contact with Precambrian basement rocks throughout much fo the Echo Park Graben area. Drill depths to 2,000 feet revealed the existence of Echo Park sediments filling broad, meandering paleochannels eroded into the Precambrian rocks. Anomalous uranium mineralization was noted in many drill holes, however grade and thickness of the mineralization were insufficient for development at the time. Exploration activity virtually ceased by early 1970.

The district remained dormant to new exploration activity until 1974 when Cyprus Mines Corporation began exploration in the High Park area. After moderate exploration success at High Park, Cyprus shifted exploration activity to the Tallahassee Creek locality. The first significant mineralization to be discovered was located on a trend extension of the Picnic Tree Mine along Middle Tallahassee Creek. The Picnic Tree ore deposit had been discovered and mined during the 1950's. Cyprus eventually drilled out about 3.5 million pounds U_3O_8 along an east-west paleochannel in the Ash Fall unit of the Tallahassee Creek Conglomerate. The mineralization was found on a remnant of an upraised fault block at depths up to 250 feet. The predominant ore mineral is uraninite. The average grade of the ore is 0.08 percent U_3O_8.

Continued exploration eventually led to the discovery of the Hansen ore deposit between one and two thousand feet north of the Picnic Tree fault block. The Hansen orebody is a stratiform deposit that occurs in an interbedded sandstone, mudstone and pebble to boulder conglomerate facies of the lower Echo Park Formation. The top of the ore deposit is at a depth of about 500 feet below the surface; the bottom is at about 750 feet. The mineralization is interbedded with barren siltstone, sandstone and conglomerates, and is irregular in lateral extent. The orebody appears to have been deposited in a geochemical cell-like system and is similar in some respects to Tertiary roll-front deposits in Wyoming. Figure 7 shows the location of the Hansen and the Picnic Tree uranium deposits, and their relationship to subsurface faulting.

Total uranium reserves in the deposit are now estimated at 26.5 million pounds U_3O_8, at an average grade of 0.08 percent U_3O_8. Uraninite and coffenite are the only uranium minerals present. There are two theories on the source of the uranium. It was leached either from Precambrian rocks or from the thick Oligocene and Miocene volcanic tuff sequence overlying central Colorado. In either case, the uranium was then carried by groundwater and precipitated in the favorable host rock.

In 1978, Cyprus Mines sold 49 percent of its interest in the two ore deposits and adjoining properties to Wyoming Mineral Corporation. Under the agreement, Cyprus is to serve as operator of the joint venture during exploration, development and production within the project area. Applications for permits required for mining and milling operations at the Hansen & Picnic Tree deposits have been filed with state and federal agencies. If the project proceeds, it is estimated that stripping could begin on the Hansen deposit in 1981, with first ore production in 1983. Development of the Picnic Tree deposit would begin later. Construction of the mill and tailings disposal dams could begin in 1981 if permits are received in a timely fashion, with initial yellow-cake production starting in 1984.

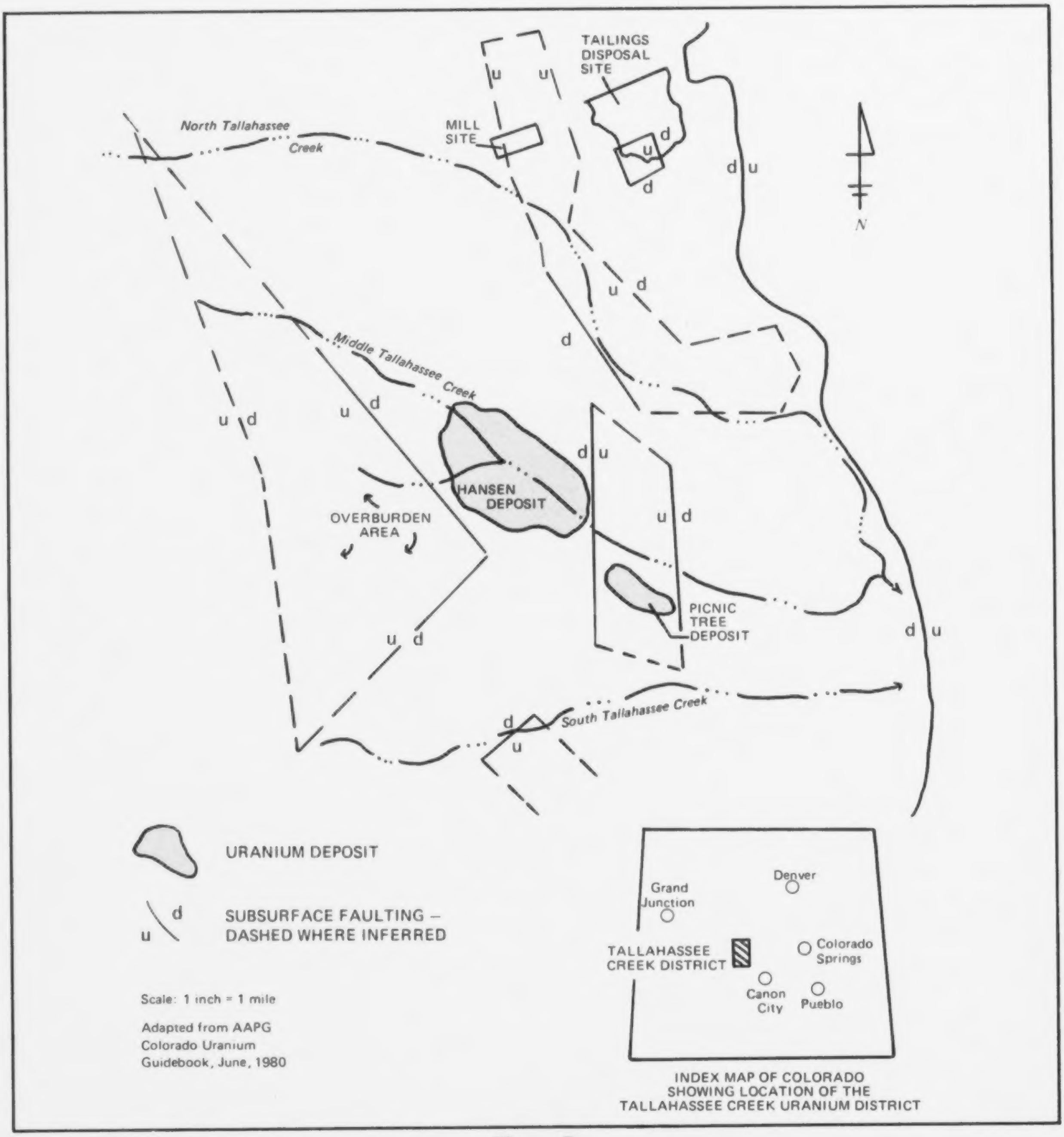
District Geology

The Echo Park Graben is a structural feature which formed in the early Tertiary Period, probably during Paleocene time. Erosion was intense during, and after, structural activity. Practically all Paleozoic and Mesozoic rocks were eroded away, and deep channels were cut into the Precambrian basement rock. This was followed by rapid deposition of Tertiary formations which eventually filled the graben with about 2,500 feet of sediments and volcanic flows.

The rock formations in the district are divided into four geologic age groups—Precambrian, Eocene, Oligocene-Miocene and Pleistocene to Recent.

Precambrian: The Precambrian underlies the entire Tallahassee Creek district. It consists of both plutonic and metamorphic rocks. The plutonic rocks, probably the Pikes Peak granite, intruded older rocks to form highly metamorphosed gneisses and schists. The rocks were later intruded by granite, pegmatite and finally, quartz veins. The structural complexity of the sequence is related to the Laramide orogeny of Late Cretacous and early Tertiary time, and later formation of the Echo Park Graben. The graben forms the eastern and western boundaries of the Tallahassee Creek District.

Eocene: The Eocene time marked the beginning of a long period of fluvial deposition and extensive erosion in the district. Eocene sediments, which may be at least 1300 feet thick, began filling the graben ara before the end of structural activity. Topographic


TAILINGS DISPOSAL SITE
MILL SITE
North Tallahassee Creek
Middle Tallahassee Creek
HANSEN DEPOSIT
OVERBURDEN AREA
PICNIC TREE DEPOSIT
South Tallahassee Creek
N
u d
URANIUM DEPOSIT
SUBSURFACE FAULTING – DASHED WHERE INFERRED
Denver
Grand Junction
TALLAHASSEE CREEK DISTRICT
Colorado Springs
Canon City
Pueblo

Scale: 1 inch = 1 mile

Adapted from AAPG Colorado Uranium Guidebook, June, 1980

INDEX MAP OF COLORADO SHOWING LOCATION OF THE TALLAHASSEE CREEK URANIUM DISTRICT

Figure 7
LOCATION MAP OF THE TALLAHASSEE CREEK URANIUM DEPOSITS, TALLAHASSEE CREEK URANIUM DISTRICT, FREMONT COUNTY, COLORADO

RAW MATERIALS

lows in the Precambrian rock began filling with boulder conglomerates derived by residual weathering of steep graben walls. This represents the fanglomerate facies of the Echo Park Formation. As the graben began to fill, flowing streams eroded the fanglomerates and deposited thick sequences of sediments consisting of widely disbursed fine to coarse arkosic sandstones, interbedded with lenses of siltstone, claystone and pebble to boulder conglomerates. Carbonaceous material is more common to this sequence than it is to the fanglomerates. This type of deposition forms approximately 60 to 70 percent of the total Echo Park Formation.

Rapid erosion occurred simultaneously with deposition. Early sediments were reworked and redeposited as part of the constant changing sedimentary cycle. Thickening of sediments is significant where deposition occurred in stream channels which had eroded into older Echo Park sediments and Precambrian rocks. The thicker segments of the lower Echo Park fluvial system is the host for uranium mineralization at the Hansen ore deposit and at least two small deposits discovered in the 1950's.

Oligocene to Miocene: The oldest volcanic unit is the Wall Mountain Tuff of Oligocene Age. Deposition was widespread throughout the entire region. It is a rhyolitic, ash-flow, welded tuff from 0 to 150 feet thick. At Tallahassee Creek, the tuff overlies the Echo Park Formation, but it is commonly in unconformable contact with Precambrian rocks where the Echo Park was removed by erosion. The Wall Mountain Tuff was also subjected to extensive erosion.

The Tallahassee Creek Conglomerate, also of Oligocene Age, overlies the Wall Mountain Tuff. The formation is divided into three members which have a combined thickness of about 400 feet. The oldest member is the Tallahassee Creek Conglomerate which is up to 350 feet thick. It consists of coarse to boulder sized volcanic debris with clay and sand matrix. Interbedded tuffaceous and arkosic sandstones and claystones are common, and offer evidence of breaks in the rapid deposition of coarse material.

The middle member is the Hansen Andesite-Latite. It has been identified only locally within the area of the Hansen deposit. It is characterized by a porphyritic texture of the andesite or latite, and partial alteration of phenocyrsts to clay. Formation thickness is up to 45 feet.

The upper unit is the Tallahassee Creek Ash Fall Member. It is almost always present as the upper zero to ten feet of the Tallahassee Creek Conglomerate. It consists of kaolinitic and bentonitic claystone with occasional tuffaceous sands and pebble conglomerates. During deposition of the Ash Fall, stream erosion was common. The ash was reworked and redeposited with carbonaceous material on a highly irregular surface. The Ash Fall Member is the host for uranium mineralization at the Picnic Tree deposit as well as the majority of deposits discovered in the 1950's.

The Thirty-nine Mile Andesite overlies the Tallahassee Creek Conglomerate. It was deposited over a broad area of central Colorado. It varies in thickness from zero to 800 feet and consists of highly altered and brecciated andesite. The lower portion contains interbedded tuffaceous waterlain sediments, and unconsolidated basal volcanic breccia. The upper portion contains several ash flows and volcanic deposition, all of which are part of the greater Thirty-nine Mile volcanic field. The combined sequence marks the end of Oligocene and probably Miocene volcanic deposition.

Pleistocene to Recent: Structural activity was renewed during late Miocene and probably Pleistocene time. Block faulting elevated the formations to their presently existing levels. This is well illustrated by the position of the Picnic Tree ore deposit with relation to the Hansen ore deposit as shown in Figure 7. The present surface topography within the district was developed primarily by erosion and downcutting of Tallahassee Creek. Recent gravels and aluminum were derived and deposited by this action.

STATISTICAL DATA

EXCHANGE VALUE—31.50/lb U_3O_8
Determined as of June 30, 1980

Definition

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of June 30, 1980

$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
37.60	4.1	17	5

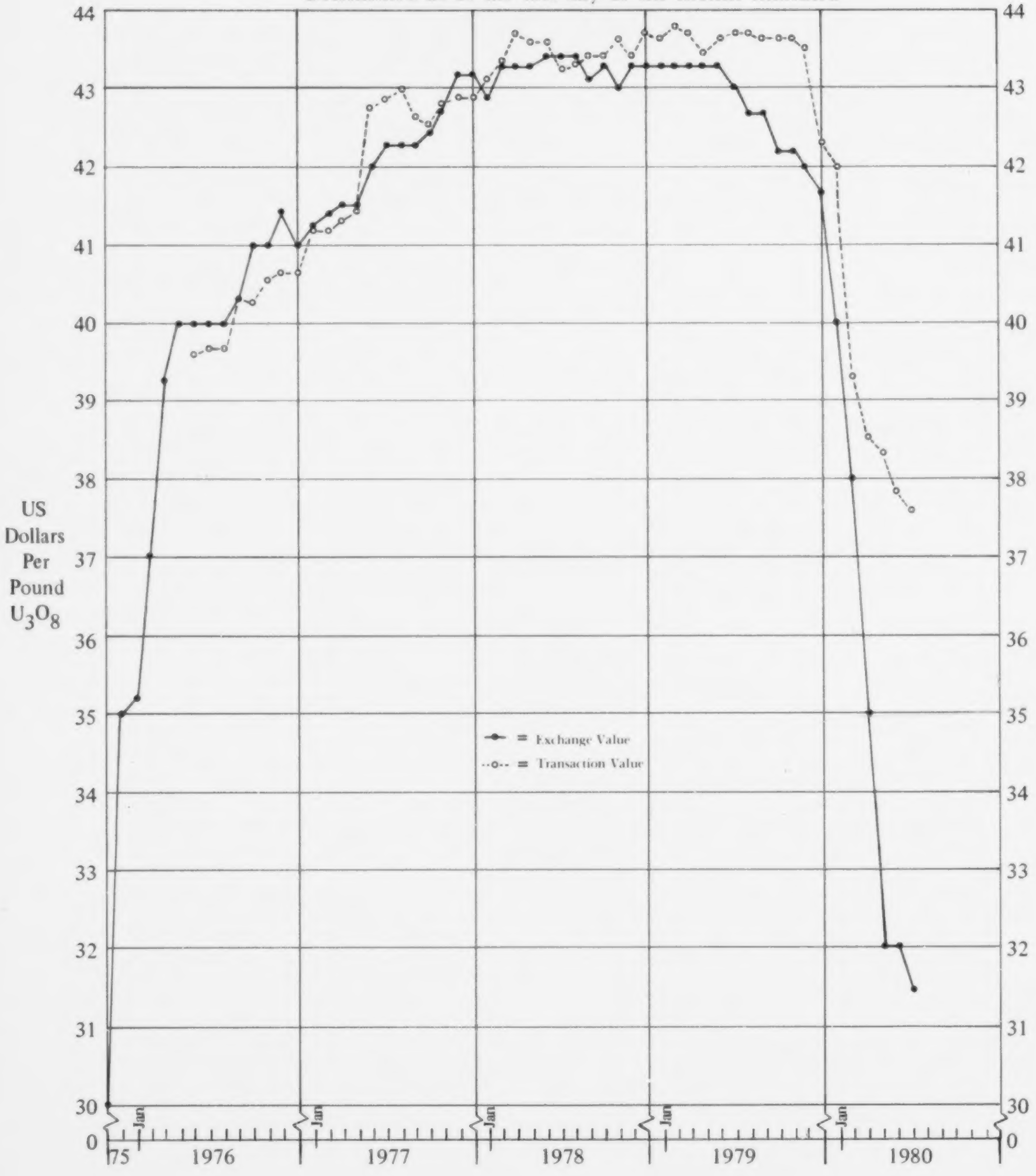
Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES SINCE NOVEMBER 1975

Determined as of the last day of the month indicated



STATISTICAL DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated
(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50						

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated
(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60						

Note: See Nuexco Report 135 for a discussion of the definition of Transaction Value.

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	31.50	69.44	81.89
France (franc)	129.15	284.73	335.77
FRG (mark)	55.47	122.28	144.21
Japan (yen)	6,830	15,058	17,757
Switzerland (franc)	51.18	112.84	133.07
UK (pound)	13.41	29.57	34.87
Australia (dollar)	27.22	60.03	70.79
Canada (dollar)	36.25	79.93	94.25
Niger, Gabon (CFA)	6,458	14,237	16,789
South Africa (rand)	24.31	53.60	63.22

*Calculated using currency exchange rates published in the Wall Street Journal on the last Friday of the month.

LOAN USE CHARGE RATE—7.0%/year

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

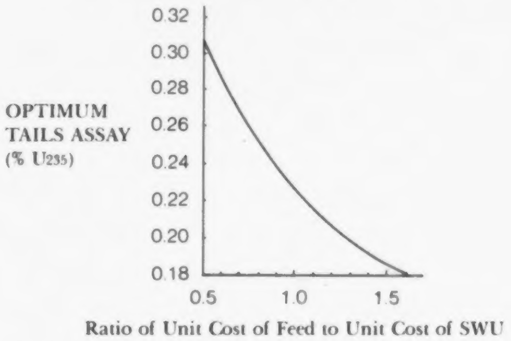
Nuexco Reference Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as percent of Current E.V.	Seller Group	Buyer Group	Remarks
1140	80	50 to 100	–	Europe	Europe	Loan; return in 83.
1144	80	Less than 50	113	US	US	UF_6
1145	80	100 to 300	100	US	US	
1147	80	Less than 50	–	US	Canada	Enriched UF_6; definitive price information not available
1148	80	Less than 50	100	US	US	

*Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

OPTIMUM TAILS ASSAY

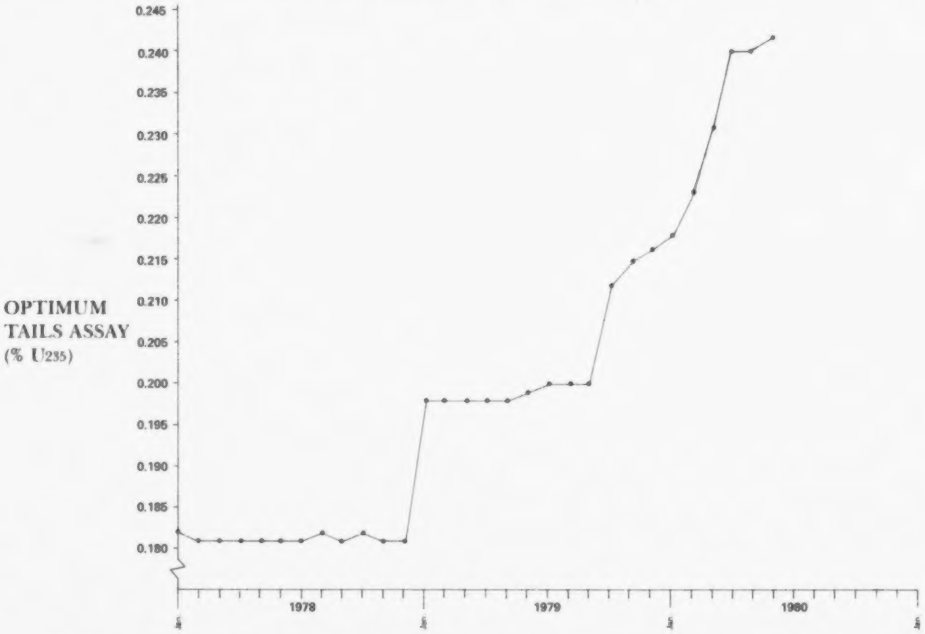
The optimum tails assay is the tails composition at which the cost of enriched uranium is lowest for given costs of separative work (SWU) and natural uranium feed. It depends only on the ratio of the cost of a kilogram of natural uranium in the form of UF_6 to the cost of a kilogram unit of separative work. The US Department of Energy (USDOE) Adjustable Fixed Commitment (AFC) enrichment contract holders have the option, within limits, to specify the transaction tails assay. The transaction tails assay for USDOE Requirements contracts is 0.2 percent U_{235}. For every one-hundredth of one percent increase in the transaction tails assay, uranium consumption increases about two percent.

TAILS ASSAY FOR MINIMUM COST OF PRODUCT*



*From Nuexco Report 138

HISTORICAL OPTIMUM TAILS ASSAY[1]



[1] Based on Exchange Value and USDOE AFC SWU price; interpolated to the nearest thousandth.

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 199)[1]	Consumer Price Index (1967 = 100)[2]	GNP Implicit Price Deflator (1972 = 100)[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]		
				Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)
Annual Avg. 1970(5)	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971(5)	114.1	121.3	96.02	4.12	4.15	3.97
Annual Avg. 1972(5)	117.9	125.3	100.00	4.56	4.59	4.26
Annual Avg. 1973(5)	125.9	133.1	105.80	4.84	4.98	4.51
Annual Avg. 1974(5)	153.8	147.7	116.02	5.44	5.63	4.88
Annual Avg. 1975(5)	171.5	161.2	127.15	6.13	6.24	5.39
Annual Avg. 1976(5)	182.4	170.5	133.71	6.76	6.87	5.91
Annual Avg. 1977(5)	195.1	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978(5)	209.4	195.4	152.05	8.23	8.56	7.01
Annual Avg. 1979	236.3P	217.4	165.46	9.27	9.50	7.59
Mar 1979	225.4	209.1	160.22	8.84	9.11	7.36
Apr 1979	229.0	211.5	—	9.03	9.49	7.50
May 1979	231.6	214.1	—	9.06	9.15	7.47
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9	—	9.32	9.57	7.60
Aug 1979	240.6	221.1	—	9.38	9.70	7.65
Sep 1979	244.2	223.4	167.20	9.63	9.79	7.73
Oct 1979	249.0	225.4	—	9.67	9.87	7.82
Nov 1979	250.6R	227.5	—	9.79	9.86	7.87
Dec 1979	253.1	229.9	170.58	9.80	9.92	7.91
Jan 1980	260.3	233.2	—	9.92	10.06	7.96
Feb 1980	265.4	236.4	—	9.93	10.01	7.99
Mar 1980	268.2	239.8	174.51	9.91	10.23	8.04
Apr 1980	270.7	242.5	—	10.04P	10.31P	8.11P
May 1980	271.2P	—	—	—	—	8.15P

P = Preliminary R = Revised since last month

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. All data for 1977 and beyond are adjusted to the most recent benchmark—March 1978—and are subject to revision from that point forward, with the advent of the next benchmark scheduled for publication in late 1980.

(5) Data for 1970-1978, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Nuexco Report 139.

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry—All Groups (Year 1968-69 = 100.0)[1]	Weighted Average Minimum Weekly Wage Rates—Adult Males Australia Mining and Quarrying (A$)[2]
Annual Avg. 1970 (3)	101.4	59.88
Annual Avg. 1971 (3)	101.5	65.95
Annual Avg. 1972 (3)	105.6	71.26
Annual Avg. 1973 (3)	124.4	78.96
Annual Avg. 1974 (3)	141.9	108.07
Annual Avg. 1975 (3)	150.4	132.55
Annual Avg. 1976 (3)	168.4	160.93
Annual Avg. 1977 (3)	192.0	179.03
Annual Avg. 1978 (3)	215.4	190.04
Annual Avg. 1979	248.5	196.34
Jan 1979	246.3	189.97R
Feb 1979	253.0	190.19R
Mar 1979	264.0	191.64R
Apr 1979	273.0	192.46R
May 1979	287.5	193.56R
Jun 1979	293.8	196.64R
Jul 1979	295.8	199.22R
Aug 1979	290.8	200.29R
Sep 1979	300.0	201.07R
Oct 1979	307.0	200.53R
Nov 1979	308.0	199.84R
Dec 1979	317.0	200.65R
Jan 1980	337.7	214.77
Feb 1980	343.2P	214.23
Mar 1980	337.9P	213.68

P = Preliminary   R = Revised since last month

(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

(2) Australian Bureau of Statistics, Canberra; "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest twelve months shown are subject to revision.

(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Nuexco Report 138.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000)[1,2] (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings (C$)[3,4]		
		Metal Mining, including milling (SIC 050-059)	Primary Metal Industries, non-ferrous (SIC 296-298)	Chemicals and Chemical Products (SIC 370-379)
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Annual Avg. 1979	217.9R	9.60	7.35	7.67
Feb 1979	208.5	9.24	7.18	7.36
Mar 1979	210.4	9.47	7.20	7.51
Apr 1979	212.8	9.68	7.26	7.63
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3	9.37	7.34	7.73
Aug 1979	220.0	9.56	7.38	7.77
Sep 1979	223.4	9.75	7.50	7.81
Oct 1979	227.4	9.89	7.54	7.88
Nov 1979	228.1	9.97	7.61	7.91
Dec 1979	230.4R	9.93	7.51	7.89
Jan 1980	238.8R	9.96	7.57	7.99
Feb 1980	240.6R	10.11P	7.69P	8.08P
Mar 1980	239.0	10.31P	7.83P	8.27P
Apr 1980	240.3P	—	—	—

P = Preliminary R = Revised since last month

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 4.10 of Nuexco Report 138.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 4.11 of Nuexco Report 138.

STATISTICAL DATA

REPUBLIC OF SOUTH AFRICA STATISTICS

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100, except where otherwise indicated)
Annual Avg. 1970 (3)	7.34	100.3 (4)
Annual Avg. 1971 (3)	7.88	106.4 (4)
Annual Avg. 1972 (3)	8.79	113.3 (4)
Annual Avg. 1973 (3)	10.51	124.1 (4)
Annual Avg. 1974 (3)	13.18	138.5 (4)
Annual Avg. 1975 (3)	16.71	157.2 (4)
Annual Avg. 1976 (3)	19.30	174.7 (4)
Annual Avg. 1977 (3)	23.87	194.4 (4)
Annual Avg. 1978 (3)	27.14	137.2
Annual Avg. 1979 (3)	30.18	155.3
Mar 1979	28.60	148.6
Apr 1979	–	149.9
May 1979	–	150.6
Jun 1979	29.44	152.4
Jul 1979	–	157.9
Aug 1979	–	160.2
Sep 1979	30.71	162.1
Oct 1979	–	162.9
Nov 1979	–	163.4
Dec 1979	31.89	164.0
Jan 1980	–	165.4
Feb 1980	–	167.0
Mar 1980	33.65	168.0
Apr 1980	–	170.0
May 1980	–	171.9

---

(1) Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly.
(2) Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Price Index for Urban Areas."
(3) Historical data for 1970 through 1979 appear on page 4.9 of Nuexco Report 140.
(4) April 1970 = 100.00

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM SUPPLY

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8)				Remarks
	1980	1981	1982	1983	
Available for Sale:					
1213	700				
1236			150	150	
1274	150				
1284	250				
1286	350	150	150	150	
1306		100	200	200	
1315			200	200	
1325	750				
1338	250				
1346	100				
1377	50				
1392	300				
1394	250				
1403	150				
1417	800				UF_6
TOTALS	4100	250	700	700	
Available for Loan:					
1175	700				UF_6
1234	700				
1354	600				UF_6
1355	600				
1429	500				
TOTAL	3100				

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM DEMAND

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8)				Remarks
	1980	1981	1982	1983	
Inquiries to Purchase:					
1146		100	200	200	
1335	300				
1357		300			
1396	200				
1406	50				UF_6
1408	150				
1410		2000	2000	2000	
1437		70			
1444	50				
TOTALS	750	2470	2200	2200	
Inquiries to Borrow:					
1220	1000				
1348	350				
1415	600				
TOTAL	1950				

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the secondary market for UF_6 conversion services. The data presented in this section are in no way intended to be indicative of the entire market for the time period covered.

CONVERSION SUPPLY

Nuexco Reference Number	Delivery Period (Thousands of Pounds U as UF_6) 1980	1981	1982	1983	Remarks
P-1282	250	250			
P-1424	1000				
P-1449		750			
P-1450	750				
P-1451	175				
TOTALS	2175	1000			

CONVERSION DEMAND

Nuexco Reference Number	Delivery Period (Thousands of Pounds U as UF_6) 1980	1981	1982	1983	Remarks
P-1424-A	190				

NUEXCO
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NUEXCO

AUGUST 1980 NUMBER 144

Monthly Report on the Uranium Market

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT 144

The **Exchange Value** remained at $31.50 per pound U_3O_8. Several Transactions closed this month at prices consistent with the Exchange Value, and other potential transactions are in the final stages of negotiation. More than three million pounds U_3O_8 remain available for sale this year. While the sellers of much of this material are holding out for prices considerably higher than Exchange Value, some sellers remain willing to do business at current price levels. Inventory holders remain a force in the market; about seventy percent of material available for 1980 delivery is being offered by inventory holders.

Nuexco has recalculated its estimates of **Apparent Future Consumption**, and the results are presented in this Report. There was little near term change outside of the **US**. However consumption (defined as uranium entering the enrichment-fabrication pipeline) in the US decreased substantially as a result of the continued licensing logjam at the USNRC. Cumulative US consumption through 1990 decreased by more than 50 million pounds U_3O_8 from the last Nuexco estimate, published only four months ago. More than 80 percent of the decrease is in the years 1980 through 1983. Consumption during 1980 for US reactors under construction dropped to essentially zero. The new estimates of US consumption through 1984 are tabulated below, along with Nuexco's estimate of US production, both in millions of pounds U_3O_8:

	1980	*1981*	*1982*	*1983*	*1984*
Consumption	18	25	30	35	40
Production	36	35	35	33	30

On a worldwide level, the supply excess is more severe. Worldwide production is estimated to exceed consumption by an average of 35 million pounds per year during the years 1980 through 1984.

The first long term contract between a US utility and the new wave of **Australian** producers was announced this month. American Electric Power Company and the Ranger partners signed an agreement covering 4.5 million pounds U_3O_8 for delivery from 1982 through 1990.

The chairman of **South Africa's** Anglo American group stated that important quantities of uranium would probably be stockpiled by South African gold-uranium producers over the next five years. The apparent objective is to avoid putting additional downward pressure on the market.

The make versus buy option is treated in this month's *Topical Essay*, as it relates to uranium producers. Due to the current relationship between spot uranium prices and variable production costs, it appears that many US uranium producers would be considering purchasing uranium to deliver under pre-existing contracts.

This month's *Raw Materials* section covers the uranium industry in the Republic of Niger.

This Executive Summary may be reproduced for internal distribution.

8/80

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NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

August 1980 No. 144

JAMES E. VAUGHAN *EDITOR*

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FOREWORD

There were two typographical errors in last month's Report, Number 143. In the discussion of Transaction Value in the left-hand column of page 7, it was observed at the bottom of the page that if the Transaction Value was calculated using only the data for the past four months, thus dropping transactions reported in March, the Transaction Value would have been $30.70 per pound U_3O_8. This was in error; the correct figure is $33.70.

The second error was on page 5 under the discussion of Korea. The startup date for Wolsung 1 was incorrectly stated as April, 1980. It should have read April, 1983.

URANIUM MARKET

GENERAL

Estimates of Apparent Future Consumption

In Nuexco Report 140 (April 1980) Nuexco presented revised estimates of Apparent Future Consumption of U_3O_8. Subsequent events warrant revising those estimates once again. Table 1 below contains Nuexco's estimates of Apparent Future Consumption as of July 31, 1980. (The term consumption as used by Nuexco refers to U_3O_8 entering the enrichment-fabrication pipeline.) The corresponding installed nuclear electric generating capacities are shown in Table 2.

US. Nuexco Report 140 contained the following paragraph:

> *The US has undergone some dramatic changes in the past eight months. Reaction to the accident at Three Mile Island, regulatory problems, double-digit inflation, soaring interest rates, and reduced projections of utility load growth have contributed to numerous cancellations, deferrals or delays of nuclear power plants. Although Nuexco's current estimates represent a cumulative reduction (since the last Nuexco estimate, July 31, 1979) of more than 50 million pounds U_3O_8 in US consumption through 1990,* further reductions can still be expected.

Although it was anticipated, this reduction in estimated US uranium consumption has occurred faster and to a greater extent than expected. Of 93 US reactors designated by Nuexco as under construction or on order as of July 31, 1980, 71 have undergone schedule delays during the four month period since March 31, 1980, when Nuexco's previous estimate was published. The weighted average delay in dates of commercial operation, as estimated by Nuexco, for all US plants under construction or on order is more than 22 months.

Table 3 contains a comparison between the Apparent Future Consumption estimates published in Nuexco Report 140 and that published in this Report, for US plants under construction and on order. The cumulative reduction through 1990 is more than 50 million pounds. More than 80 percent of the reduction is in the years 1980 through 1983.

The maximum anticipated annual level of US consumption during the 1980's is only slightly lower than in the previous estimate. Table 1 indicates a maximum US consumption level of about 49 million pounds U_3O_8 per year, attained in 1988. However the anticipated consumption level for 1980 is 10.2 million pounds U_3O_8 lower than the previous estimate. This reduction is almost solely attributable to the licensing moratorium by the US Nuclear Regulatory Commission in the wake of the Three Mile Island accident. The moratorium has been officially terminated, but as of this writing there still have been no new licenses in the US for power operation and few, if any, are expected in the near future. The result is a very large decrease in near term estimated consumption for US plants under construction. The same explanation holds for the large reductions in estimated consumption in the years 1981 through 1983. This development was foreshadowed in Nuexco Report 140:

> *. . . Under current conditions in the NRC, it is likely that no more than six to eight US reactors can be licensed in a given year. Therefore about half of the anticipated 1980 startups will very likely be delayed to 1981. Likewise, many anticipated 1981 startups will be delayed to 1982, 1982 startups to 1983 or 1984, and so on. Under this scenario, additional startup delays of forty reactor-years or more are likely . . .*

Nuexco's current estimate is that total startup delays will be more than 150 reactor-years from the estimate of only four months ago! The delays which have led to the current reduction in estimated consumption will almost certainly serve to further exacerbate the imbalance in the uranium market, which has been discussed in detail in recent Nuexco Reports.

Europe. Nuexco's current estimate of Apparent Future Consumption for Europe represents a cumulative increase through 1990 of approximately 19 million pounds U_3O_8 since the estimate of Report 140. Some of this increase is attributable to new orders; the rest to accelerated construction schedules. There have been several reactor construction starts, and some new reactors have been placed on order.

Far East. Nuexco's current estimate of Apparent Future Consumption is not significantly different from the estimate of Report 140 in their annual totals. However, a substantial shift has taken place as several reactors formerly designated as on order are now under construction.

Methodology. In order to facilitate interpretation of the results presented, the methodology used in developing the concept of Apparent Future Con-

URANIUM MARKET

Table 1

APPARENT FUTURE CONSUMPTION[1]

(millions of pounds U_3O_8)

BUYER GROUP	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
United States												
Reactors Now Operational	16.5	17.4	17.4	17.1	18.0	18.0	18.1	17.4	17.6	18.3	18.2	17.7
Now under Construction	8.2	0.7	7.5	12.8	17.2	22.2	25.4	30.0	27.1	30.3	27.2	27.6
Now on Order	0	0	0	0	0	0	0	0.9	0.3	0.3	3.4	2.0
US Subtotal	24.7	18.1	24.9	29.9	35.2	40.2	43.5	48.3	45.0	48.9	48.8	47.3
Europe												
Reactors Now Operational	12.8	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6
Now under Construction	22.0	14.6	22.5	22.6	21.7	21.1	21.5	21.8	21.1	21.1	21.1	21.1
Now on Order	0	0	0	0.9	4.1	6.0	11.6	7.9	11.8	8.7	9.7	9.7
European Subtotal	34.8	29.2	37.1	38.1	40.4	41.7	47.7	44.3	47.5	44.4	45.4	45.4
Far East[2]												
Reactors Now Operational	4.6	4.6	4.6	4.6	4.6	4.7	4.7	4.7	4.7	4.7	4.7	4.7
Now under Construction	1.5	2.8	3.1	6.8	7.8	6.1	7.9	6.4	6.7	6.7	6.7	6.7
Now on Order	0	0	0	0	0	0	3.3	1.0	1.0	1.4	1.4	1.4
Far East Subtotal	6.1	7.4	7.7	11.4	12.4	10.8	15.9	12.1	12.4	12.8	12.8	12.8
Other Free World[3]												
Reactors Now Operational	2.3	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Now under Construction	0.7	0.8	2.2	3.7	3.7	3.8	3.8	5.0	4.5	4.5	4.5	4.5
Now on Order	0	0	0	0	0	1.5	0.3	0.6	2.1	1.3	1.3	1.9
Other Subtotal	3.0	3.0	4.4	5.9	5.9	7.5	6.3	7.8	8.8	8.0	8.0	8.6
FREE WORLD[3] TOTAL	68.6	57.7	74.1	85.3	93.9	100.2	113.4	112.5	113.7	114.1	115.0	114.1
WORLDWIDE BREAKDOWN BY STATUS:												
Reactors Now Operational	36.2	38.8	38.8	38.5	39.4	39.5	39.6	38.9	39.1	39.8	39.7	39.2
Now under Construction	32.4	18.9	35.3	45.9	50.4	53.2	58.6	63.2	59.4	62.6	59.5	59.9
Now on Order	0	0	0	0.9	4.1	7.5	15.2	10.4	15.2	11.7	15.8	15.0

[1] Computed quantities of U_3O_8 which would be used under the given conditions, to fabricate fuel for loading and reloading reactors operating, under construction or on order as of July 31, 1980. Compiled and computed on a reactor-by-reactor basis, quantities for each reactor are based on specific core characteristics, 0.20% tails assay, no recycling, 24-month lead time for procuring first cores and 18-month lead time for procuring each reload. Where reload schedule is not already known, these estimates assume reloads occur one year after commercial operating date and annually thereafter. 1979 figures reflect actual capacity factor achieved by each reactor. Estimates for 1980-1990 use Nuexco estimates of individual reactor capacity factors.

[2] Japan, Korea, Taiwan.

[3] Excludes Bulgaria, Czechoslovakia, German Democratic Republic, Finland (2 Russian reactors), Hungary, Poland, Romania, USSR.

URANIUM MARKET

Table 2
NUCLEAR ELECTRIC GENERATING CAPACITY[1] [2]
(thousands of MWe—net)

BUYER GROUP	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
United States												
Reactors now Operational	50.0	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9
Now under Construction	0	4.3	7.7	10.4	17.8	30.2	38.4	49.2	60.0	70.3	75.0	79.5
Now on Order	0	0	0	0	0	0	0	0	0	2.3	2.3	4.5
US Subtotal	50.0	55.2	58.6	61.3	68.7	81.1	89.3	100.1	110.9	123.5	128.2	134.9
Europe												
Reactors Now Operational	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3
Now under Construction	0	7.0	26.1	36.2	48.0	55.9	58.8	59.8	60.8	61.8	61.8	61.8
Now on Order	0	0	0	0	0	0.9	5.6	11.8	20.9	24.7	28.6	28.6
Europe Subtotal	36.3	43.3	62.4	72.5	84.3	93.1	100.7	107.9	118.0	122.8	126.7	126.7
Far East[3]												
Reactors Now Operational	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
Now under Construction	0	0	1.5	4.0	6.3	11.6	17.2	19.0	21.0	21.0	21.0	21.0
Now on Order	0	0	0	0	0	0	0	0	3.0	3.9	3.9	3.9
Far East Subtotal	16.3	16.3	17.8	20.3	22.6	27.9	33.5	35.3	40.3	41.2	41.2	41.2
Other Free World[4]												
Reactors Now Operational	6.5	6.5	6.5	6.	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Now under Construction	0	0.4	1.0	2.5	4.7	8.4	10.3	11.1	11.8	13.1	13.1	13.1
Now on Order	0	0	0	0	0	0	0	0.6	1.2	1.2	3.3	4.2
Other Subtotal	6.5	6.9	7.5	9.0	11.2	14.9	16.8	18.2	19.5	20.8	22.9	23.8
FREE WORLD[4] TOTAL	109.1	121.7	146.3	163.1	186.8	217.0	240.3	261.5	288.7	308.3	319.0	326.6
WORLDWIDE BREAKDOWN BY STATUS												
Reactors Now Operational	109.1	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
Now under Construction	0	11.7	36.3	53.1	76.8	106.1	124.7	139.1	153.6	166.2	170.9	175.4
Now on Order	0	0	0	0	0	0.9	5.6	12.4	25.1	32.1	38.1	41.2

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[1] Installed as of year end.

[2] Uses Nuexco estimates of commercial operating dates.

[3] Japan, Korea, Taiwan.

[4] Excludes Bulgaria, Czechoslovakia, German Democratic Republic, Finland (2 Russian reactors), Hungary, Poland, Romania, USSR

Table 3

COMPARISON OF NUEXCO ESTIMATES OF US APPARENT FUTURE CONSUMPTION: REPORT 140 (APRIL, 1980) VS. REPORT 144 (AUGUST, 1980)

(millions of pounds U_3O_8)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
US Reactors under Construction											
Report 140[1]	10.9	19.4	22.2	24.3	23.4	22.8	25.0	25.2	25.2	25.0	24.9
Report 144	0.7	7.5	12.8	17.2	22.2	25.4	30.0	27.1	30.3	27.2	27.6
Annual Difference	10.2	11.9	9.4	7.1	1.2	(2.6)	(5.0)	(1.9)	(5.1)	(2.2)	(2.7)
US Reactors on Order											
Report 140[1]	-0-	-0-	-0-	2.0	2.4	4.8	4.4	4.3	5.6	7.8	7.3
Report 144	-0-	-0-	-0-	-0-	-0-	-0-	0.9	0.3	3.4	2.0	2.0
Annual Difference	10.2	11.9	9.4	9.1	3.6	2.2	(1.5)	2.1	0.2	2.2	2.6
Cumulative Difference	10.2	22.1	31.5	40.6	44.2	46.4	44.9	47.0	47.2	49.4	52.0

[1] Estimates for Arkansas Nuclear unit 2 have been removed from this category, since the unit entered commercial operation between the two dates of estimate.

sumption, first published in Nuexco Report 128, and developed further in Reports 132 and 140, is repeated here in condensed form:

1. Estimates of Apparent Future Consumption are not forecasts of uranium demand. Rather, these estimates comprise a portion of uranium demand. As indicators of the amount of uranium needed to fuel the reactors under consideration, these estimates should be regarded as relatively hard demand in the sense that this portion of demand is quite insensitive to uranium prices. Market demand for the assumed pattern of capacity additions can be higher or lower, depending on users' inventory policies.
2. Factors which can cause demand to exceed Apparent Future Consumption are:
    a. Utility buyers plan their procurement strategies to achieve a very high probability of having access to at least enough uranium to meet commitments as they arise;
    b. Accelerated reactor construction schedules can advance the dates of uranium need;
    c. Buyers may elect to purchase uranium in excess of need, simply to enhance security of supply.
    d. Utility obligations to suppliers of fuel cycle services such as conversion, enrichment or fabrication, may require earlier purchase of uranium than a reactor's operating schedule would otherwise indicate.
3. Demand can fall short of Apparent Future Consumption if uranium inventories are reduced in order to fill needs which would otherwise appear as demand.
4. Apparent Future Consumption is based on information available today, subject to frequent revision as the date of consumption draws nearer.
5. Uranium is deemed to have been consumed when it has entered the enrichment-fabrication pipeline for ultimate use in a reactor.
6. Reactor loading was calculated, for each reactor, based on its individual core characteristics. This technique is distinct from the method customarily used in estimating reactor requirements simply as a direct function of installed capacity.
7. The estimates assume that:
    a. U_3O_8 deliveries for first cores predate commercial operation by two years.
    b. First reload occurs 12 months after commercial operating date and annually thereafter.
    c. U_3O_8 delivery for each reload predates refueling outage by 18 months.
8. Using the assumptions listed above, the estimate for a given reactor can be computed as a function

URANIUM MARKET

of assumed capacity factor, tails assay and commercial operating date.

9. Reactors fueled by the USSR are excluded from Nuexco's estimates. Although Soviet bloc reactors account for substantial demand, Soviet participation in uranium trading in the Western market has been negligible and appears likely to remain so.
10. Actual commercial operating dates can vary widely from published dates. Nuexco uses the best information available, much of it from unpublished sources, to prepare its own estimates of operating dates.
11. These estimates make no provision for orders not yet placed. Only the requirements associated with reactors operating, under construction or on order are included. Consequently, none of these estimates can be compared directly to forecasts of uranium requirements. Rather, these estimates should be regarded as minimum requirements.
12. The analysis period of 11 years was chosen as an arbitrary measure of the longest expected time interval between inception and commercial operation of a nuclear power plant.
13. The total of approximately 51,000 MWe (net) in Table 2 under the classification of *Reactors Now Operational* in the US is based on 70 reactors. Shippingport and Hanford were not included. Arkansas Nuclear unit 2 was added to the *Reactors Now Operational* category because it was declared commercial on April 25, 1980. Sequoyah unit 1, North Anna unit 2, and Salem unit 2 were not included because their licenses are for startup testing only. Consumption estimates for these reactors were included under the category of *Reactors Now Under Construction*. Included in the 70 reactors were Indian Point unit 1, Humboldt Bay, and TMI unit 2, even though these plants are indefinitely shut down. Consumption estimates included in Table 1 for the latter three units reflect their non-operational status.

AFRICA

Uranium production in the **Republic of South Africa** totaled 3.98 million pounds U_3O_8 in the second quarter of 1980, an increase of four percent over the first quarter. An expansion of the uranium treatment plant at Western Deep Levels was commissioned during the quarter.

South Africa's largest uranium producer, the Anglo-American group, has indicated in the recently published Chairman's statement that South African producers might stockpile important quantities of U_3O_8 over the next five years. This statement might reflect the possible course of action which some South African producers expect to take with respect to uncommitted production in the near and intermediate term markets. With the price of gold at its current very high level, many gold-uranium producers may be in a position to forego near term income from uranium. The objective apparently is to avoid further depressing the near term market, and to take advantage of possible future upswings.

AUSTRALIA

The long-rumored deal between Ranger and a US utility closed this month as American Electric Power and the Ranger partners, Peko-Wallsend and Electrolytic Zinc, announced the signing of uranium supply contracts covering 4.5 million pounds U_3O_8 over a nine-year period, 1982-1990. Formal approval of the Australian government is required before the contract is binding.

While the terms of the agreement have not been made public they include, presuming the agreement is in accordance with the determinations of the Australian government, floor and market price provisions and extensive safeguards. Based on current market conditions it may be presumed that the floor is at or near the reported Australian minimum of US$30.00. An interesting aspect of the contract relates to its term of nine years, which presumably is designed to moot the Australian enrichment requirement that, after 1990, buyers agree to accept a minimum of 35 percent of scheduled deliveries in the form of enriched product.

The contract was the result of a long negotiation made more difficult by a weakening market, and is the first one between the Northern Territory producers and a US buyer. Its success is particularly important to the overall Australian marketing effort in the US. It is generally conceded that if the Australian government does not approve the contract, Australian hopes of penetrating the US market would receive a severe setback.

In other developments affecting Ranger, the ERA consortium is nearing finalization, although the public stock offering is still believed to be several months off.

FAR EAST

Japan's energy supply structure is among the most fragile of large industrialized nations. Of Japan's primary energy requirements, 90 percent are imported and 75 percent come from imported oil. Since the oil suppliers are concentrated geographically there is limited diversity in transportation routes.

The economic and strategic implications of this situation are of significant and growing concern to Japan's leaders, particularly when, even with an aggressive conservation program, primary energy needs are projected to increase by more than 50 percent by the year 1990.

Thus, by 1990, Japan aims to reduce its reliance on imported oil to no more than 50 percent of its primary energy needs with the balance coming from alternate energy sources, primarily nuclear, coal, LNG, LPG and, to a lesser extent, solar, geothermal, synfuels and the other more exotic sources. Notwithstanding the public attention being given the exotic energy sources, the major investment decisions currently being made demosntrate that Japan is planning to rely on proven technologies, particularly nuclear power and coal.

UNITED STATES

Energy Fuels, Ltd. recently started up its new White Mesa uranium facility near Blanding, Utah. The mill is now running at its rated capacity of 2,000 tons ore per day. Figure 1 is a photograph of the White Mesa mill.

The Energy Information Administration (EIA) of the US Department of Energy has released its latest predictions of US installed nuclear capacity through 1995. These figures are reproduced in Table 4. Also, the EIA has estimated uranium requirements based

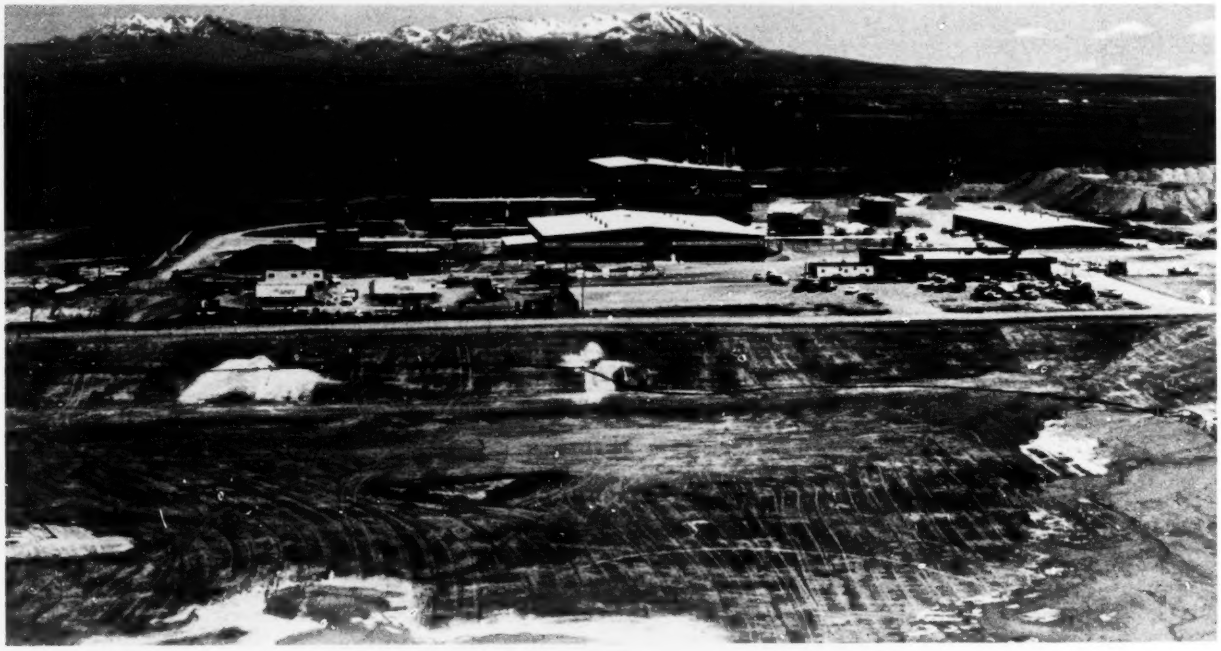

Figure 1
AERIAL VIEW OF THE RECENTLY COMPLETED WHITE MESA URANIUM MILL OF ENERGY FUELS, LTD. NEAR BLANDING, UTAH

on its nuclear power forecast, and these are reproduced in Table 5. The estimates in Table 5 were prepared by EIA at Nuexco's request and were calculated using EIA's usual computational methods. However they do not represent official EIA forecasts of uranium requirements.

Historically, the uranium market has slowed down in mid-summer. This year seems to be an exception. Some of the current activity is by buyers trying to lock in the present price level over longer term contracts. US utilities have made inquiries for intermediate and long term supply contracts for substantial quantities. Non-US origin material is being more seriously considered than in the past, as highlighted by the recently completed agreement between Ranger and American Electric Power.

TRANSACTIONS

Sales: There were six sales transactions concluded this month. One large, long term agreement was made between an Australian producer, the Ranger partners, and a US utility, American Electric Power. A small, short term sale of enriched UF_6 was made from a US utility to a non-US government agency. Another small spot sale occurred between two US producers. A US producer sold between 100,000 and 300,000 pounds U_3O_8 to a European utility for delivery in late 1980. Also, a European utility purchased between 100,000 and 300,000 pounds of U_3O_8 equivalent as UF_6 from a US producer. Finally, a non arms-length transaction was closed between two Canadian producers for 50,000 to 100,000 pounds of U_3O_8.

Loans: Two loans closed this month, both involv-

Table 4

USDOE ENERGY INFORMATION ADMINISTRATION FORECAST[1] OF NUCLEAR GENERATING CAPACITY[2]

(thousands of MWe—net)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995
LOW CASE	53.2	57.4	65.2	73.6	77.3	86.6	96.2	106.7	116.4	121.6	122.9	137.0
MID CASE	55.4	61.7	72.5	79.2	86.6	98.4	111.4	119.6	123.8	125.6	127.8	151.0
HIGH CASE	55.4	68.4	77.1	86.3	99.7	108.9	117.1	124.5	125.6	134.8	139.5	159.9

[1] As of July 31, 1980.

[2] Installed as of end of year.

Table 5

USDOE ENERGY INFORMATION ADMINISTRATION FORECAST[1] OF NATURAL URANIUM REQUIREMENTS[2, 3]

(millions of pounds U_3O_8)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995
LOW CASE	29.0	29.6	30.8	36.2	39.8	43.6	44.6	43.6	46.4	47.8	50.4	53.8
MID CASE	30.0	31.2	36.6	41.0	44.4	46.0	45.8	48.5	51.0	51.6	51.6	61.0
HIGH CASE	30.2	36.9	41.6	44.0	46.1	46.6	50.7	53.2	53.6	55.2	56.4	66.3

[1] As of July 31, 1980.

[2] Based on a capacity factor of 65%, no recycle, and 0.2% tails assay.

[3] These estimates were generated by the Energy Information Administration at Nuexco's request. Although based on the nuclear power forecasts published in EIA's *Annual Report to Congress, 1979*, they do not represent official EIA forecasts of uranium requirements.

ing between 100,000 and 300,000 pounds U_3O_8 equivalent as UF_6. In each case the lender was a US utility, while the borrower was a US producer. One of the loans commences immediately; the other is to start in early 1981. The loans are scheduled to be returned in 1983. The interest rate in both cases is consistent with the Nuexco **Loan Use Charge Rate.**

PRICING

The **Exchange Value** held at $31.50 per pound U_3O_8. Selling pressure eased somewhat this month due to the completion or near-completion of several transactions. However, demand for 1980 delivery is now virtually absent. Inquiries to sell material for 1980 delivery involve a total of 3.3 million pounds U_3O_8 equivalent, but inquiries to buy for 1980 delivery amounts to only 225,000 pounds U_3O_8. (See *Market Opportunities* section.)

Approximately 70 percent of the material currently available for sale in the near term market is being offered by inventory holders. Sellers of a large percentage of the 3.3 million pounds available for 1980 delivery continue to hold out for prices well above current Exchange Value. However, there are still several sellers willing to sell at around Exchange Value. Several potential transactions for near term delivery have entered the final stages of negotiation and are expected to close within the next few weeks.

The market weakness which precipitated the rapid decline in price can be expected to continue for some time. Continuing delays in starting up new reactors in the US has resulted in an even further decline in near term uranium usage. Table 6 compares uranium production with consumption in the US. The prolonged drought of new US reactor startups has reduced Nuexco's estimate of uranium consumption in 1980 for plants under construction almost to zero. Thus uranium production in the US in 1980 is expected to be about twice consumption. The licensing logjam will probably continue. Even though US production is expected to decline, US consumption will probably not equal US production until 1983.

The worldwide production and consumption picture is presented in Table 7. Production is expected to exceed consumption by an average of 35 million pounds per year during the years 1980 through 1984. These conditions suggest the continuation of a relatively strong buyers' market for some time.

Table 6
US URANIUM PRODUCTION AND CONSUMPTION
(millions of pounds U_3O_8)

Year	Production[1]	Consumption[2]
1980	36	18
1981	35	25
1982	35	30
1983	33	35
1984	30	40

[1] Nuexco Report 141, rounded to nearest million.
[2] This Report, Table 1, rounded to nearest million.

Table 7
WORLD[1] URANIUM PRODUCTION AND CONSUMPTION
(millions of pounds U_3O_8)

Year	Production[2]	Consumption[3]
1980	105	58
1981	116	74
1982	120	85
1983	124	94
1984	127	100

[1] Including the US, but not including Communist areas.
[2] Nuexco Report 141, rounded to nearest million.
[3] This Report, Table 1, rounded to nearest million.

The **Transaction Value** once again declined only slightly to $37.30 per pound U_3O_8. The Transaction Value continues to be dominated by transactions which closed several months ago. This month's sample extends over six months and includes 19 transactions involving a total of 4.3 million pounds U_3O_8. Eight of those transactions, accounting for 3.1 million pounds U_3O_8, closed in February 1980. At that time spot prices were considerably higher than today.

In the current thin market, the requirement to include at least two million pounds U_3O_8 in the sample is quite restrictive. Under the present definition of Transaction Value, the February transactions must

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remain in the sample until another 800,000 pounds U_3O_8 have been sold under conditions which meet the tests for inclusion in the sample. (See definition of Transaction Value in *Statistical Data* Section.)

If the requirement for a minimum sample size of two million pounds were halved, the current Transaction Value would be $33.40 per pound U_3O_8. The corresponding figure for last month would have been $33.70 (incorrectly reported last month as $30.70 due to a typographical error).

A divergence between the Exchange Value and the Transaction Value is the expected response to a sudden price change, either upward or downward, in a thin market. The degree of divergence indicates the degree to which the market has changed in recent months.

The secondary market for **conversion** services is relatively quiet. One small transaction is in the final stages of completion at a price in the range of $1.50 per pound U as UF_6. Other transactions for conversion services can probably be completed for near term delivery at about the same price. The secondary conversion market is described in Nuexco Reports 138 and 143.

TOPICAL ESSAY

PRODUCE OR PROCURE: THE URANIUM VERSION OF MAKE VERSUS BUY

One of the classic problems that confront a manufacturing manager is deciding whether to make a part in-house or to buy it from outside sources. For example, an automobile manufacturer must decide whether to make the nuts and bolts used to assemble the car, or to purchase them from an outside supplier. The recent decline in the spot market price of uranium has resulted in the uranium industry's own version of this traditional make versus buy problem. More specifically, high cost uranium producers with existing supply contracts may be in a position to determine whether they will fill their contracts with their own production or with material purchased on the spot market.

In making this choice of producing versus procuring, the decision would ideally be reduced to two comparative costs from which the cheapest option for the company would be chosen. Unfortunately, in practice, this is usually not the case. The decision is complex, and consists of at least two considerations: (a) the quantitative, deriving the economic comparison of the two options, and (b) the qualitative, which consists of all the intangible factors that go into such a decision.

In determining the quantitative difference between producing versus procuring, the controlling concept is usually the producer's *variable* cost of production. The variable cost of production is that portion of total cost which is directly related to the incremental production of the material. Total production cost of uranium concentrates, or most other products, is usually thought of as consisting of three components: fixed overhead, variable overhead and direct costs. The combination of variable overhead and direct costs make up the producer's total variable cost of production. Fixed overhead, on the other hand, is the portion of production cost which would be incurred regardless of the quantity of uranium produced. This includes such things as debt service and depreciation of fixed assets.

Variable costs include such things as direct labor involved in mining the uranium, materials and supplies used in mining, such as fuel and electricity, the cost of hauling ore from mine to mill, labor and materials used in operating the mill, some royalties, severance taxes, reclamation costs which are quantity dependent, the variable portion of overhead, and other expenses directly related to incremental production of uranium. Thus in using the variable cost in the make versus buy decision, the uranium producer is comparing the price to purchase with the real savings to be attained if production is cut. From a purely quantitative standpoint, a producer should be inclined to cut production to the extent that its incremental cost of purchasing concentrates to supply existing contracts is less than its incremental variable cost of producing those concentrates.

The cost of the purchasing option may include more than the purchase price of the concentrates, however. If a mine is to be completely shut down, for example, the cost of taking it off line and maintaining it thereafter must be included in the purchase option. In addition, some mining leases require that, if there is no production from the leased property, certain payments must be made to the lessors, or the lease may be terminated. These payments must also be included in the cost of the buy option.

While the quantitative aspect of the make versus buy decision can often be reduced to a single number, or at least a set of numbers, the qualitative aspect is far more difficult to assess. There are numerous intangible factors that must be considered in determining the outcome of the produce versus procure question.

Qualitative factors favoring the continuation of production include

- A slowdown or shutdown of work may mean the loss of skilled labor.
- It is not possible to shut down a wet mine entirely without losing it. If a mine floods, it is a total loss.
- The producer might not have the contractual right to substitute purchased concentrates under its supply contract. That is, the existing supply contract might require production from a certain ore body. However, if the spot market price is substantially below the producer's variable cost of production, the producer might benefit by renegotiating its contract with its customer to allow for substitution of purchased material, with some mechanism provided for sharing of savings between the producer and the customer.
- There may be some difficulty in obtaining suitable concentrates on short notice. This might appear improbable given the large worldwide commercial inventories of uranium. However

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these inventories are physically located at UF_6 conversion facilities, for the most part. It may therefore be difficult to transfer material in the form of concentrates to uranium producers wishing to purchase on short notice.

- Some mining leases are subject to forfeiture if there is no production from the leased property.

Qualitative factors promoting the purchase option include:

- Purchasing during a down market would enable a producer to conserve its reserves for a later time when the price might be higher.
- Uncertainties regarding precipitous changes in environmental, health, and safety legislation, and severance taxes would be mitigated by the purchase option.
- The producer's anticipated production rate may be insufficient to meet existing obligations.

These and other qualitative factors will normally go into the make versus buy decision, along with the quantitative factors. The relative effect of these intangible factors will vary in impact and magnitude and many times will be the critical factor that determines whether it is best for the producer to adopt a procurement policy, or to continue producing.

The make versus buy decision will probably not be a one-time decision, but will often be a continuous decision making function. Changes may occur from time to time which will shift the balance. The spot market price of uranium may change, production costs, especially variable costs, change frequently, and the intangible factors are in a constant state of flux.

Figure 2 indicates Nuexco's estimate of the distribution of US variable production costs for uranium. The horizontal axis represents variable production cost, excluding return on investment. The vertical axis represents the percentage of US production capacity with higher variable production cost than the cost indicated at any point on the curve (i.e. Figure 2 is an integral distribution). The cost estimate is as of the first quarter, 1980. The distribution is based on Nuexco's estimate of the *average* variable cost of each US producer.

Figure 3 indicates why the make versus buy decision has now become an important consideration in the uranium market. The Nuexco Exchange Value, since January, 1980, is plotted along with a family of curves representing the higher cost end of the US variable production cost profile. It was assumed that changes in variable production costs will roughly parallel inflation, so the costs plotted in Figure 2 have been escalated at the rate of one percent per month from the first quarter of 1980.

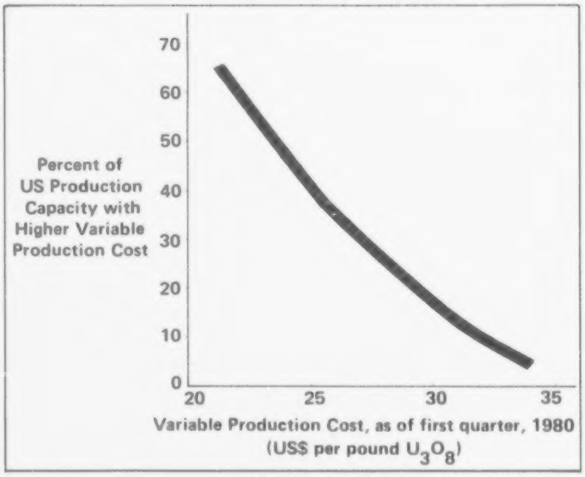

Figure 2

ESTIMATED DISTRIBUTION OF US VARIABLE URANIUM PRODUCTION COST

Figure 3 indicates that six months ago, the procure option may not have been of much interest to US producers, except in those cases where intangible factors may have indicated a buy decision. With the drop in spot prices over the past few months, combined with inflationary increases in variable costs, however, it now appears that producers producing about 25 percent of US uranium would at least be considering the buy option.

Figure 3 oversimplifies the problem somewhat in that it does not treat incidental expenses involved in the buy option, such as the cost of derating existing facilities. More importantly, the cost distribution which appears in Figure 2 and Figure 3 was based on Nuexco's estimate of each US producer's *average* variable cost. Actually, many producers have an internal distribution of production costs, especially those producers with multiple sources of ore. Thus an individual producer whose average variable cost might be below the level at which it would be economically beneficial to purchase rather than produce might still choose to purchase part of its commitments in order to phase out a part of its production capability in which variable costs are very high.

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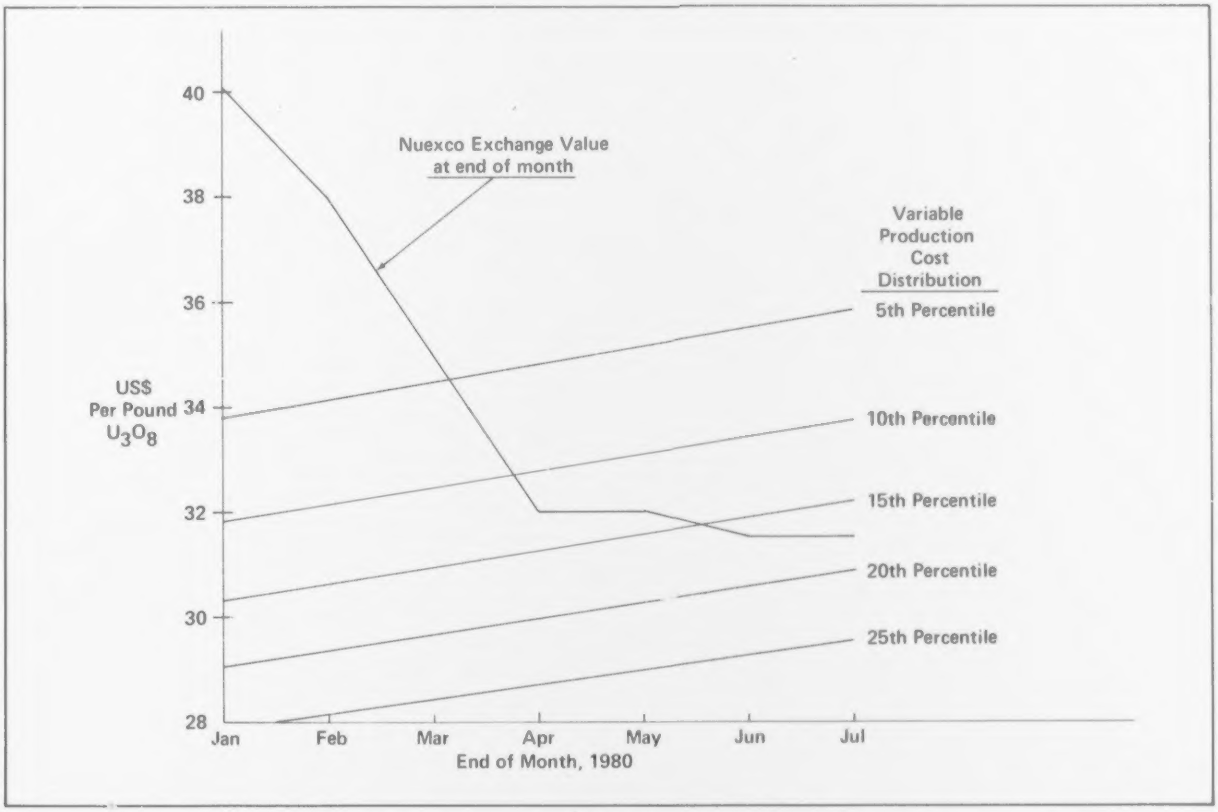

Figure 3

NUEXCO EXCHANGE VALUE COMPARED WITH VARIABLE PRODUCTION COST DISTRIBUTION OF US URANIUM PRODUCTION

COMMENTARY

COLLOQUIUM ON CONTINGENCY PLANNING FOR AN ENERGY EMERGENCY

A meeting was held in June at Stanford University among 60 of the leading academicians and industrialists in the US concerned with energy problems. It was entitled "Contingency Planning for an Energy Emergency" and dealt with examining the consequences of a sudden cutoff of oil from the Persian Gulf.

The colloquium concluded that prolonged interruption of oil supplies from the Gulf by any one of a number of scenarios (e.g. revolution, Soviet expansionism, etc.) is a real possibility. There was nearly unanimous agreement that the economy of the US and its allies would be in jeopardy if this occurred, and that immediate programs to reduce this vulnerability should be instituted.

The colloquium was sponsored by Scientists and Engineers for Secure Energy and by the Hoover Institution of Stanford. The participants considered how the energy requirements of the United States could be met if the contingency occurred. The physical limits of a national response covering a period of five years from the cutoff were investigated. Topics discussed included: emergency conservation measures; possible expansion of oil supplies from alternate sources; substitution, when possible, of gas, coal and electricity for oil; effects on electric power generation; rationing and other forms of allocation; economic effects and changes in life style; and advance preparations to reduce US vulnerability to such an occurrence.

The colloquium findings were as follows: The initial situation faced by the industrial democracies after a complete cutoff (which is a limiting case of more probably partial cutoffs) would be a shortfall of about 45% of their oil supplies, or 16 million barrrels/day. According to the existing oil-sharing agreements between the US and the other members of the International Energy Agency, the shortfall would be distributed thus:

- US oil supply would be reduced about 35%, by six million barrels/day,
- Oil supply of US allies would be reduced about 55%, by 10 million barrels/day.

Specifically, in the US, a cutoff of Mideast oil would:

- cause the transportation system to be greatly disrupted. Private automobile use would be reduced about 50%, and other vehicle transportation would be cut about 30%.
- cause massive additional unemployment of over 8 million workers, and reduce annual disposable income by over $3000 per household
- impair US ability to mobilize effectively defenses.
- lower the Gross National Product by $350-650 billion per year (about 15 to 25%)
- depending on the timing of the cutoff, in some parts of the country the closing off of some housing space could be expected, as well as accelerated movement of people to a warmer climate.
- shopping habits would undergo dramatic changes, and recreational and cultural activities would be greatly curtailed.

In the five years subsequent to an oil cutoff, assuming only present technologies could be effective on a large-scale, replacement of the US oil supply deficit by expansion of domestic and other foreign oil supplies, and by substitution of other fuels, would be substantial but still only partial (40 to 60 percent of shortfall). To avoid the vulnerability of the US to these consequences, the participants of the colloquium recommended a number of measures.

1. The security of the US requires the implementation of an aggressive program to increase both energy production and the more efficient use of oil. The object of this program should be to reduce vulnerability to loss of imported oil as quickly as possible. Examples of opportunities for increased sources of energy supply are: coal, gas, nuclear power, biomass, and on a longer time scale, shale oil. As was proved during World War II, high level policy organization is an absolute prerequisite for organizing and implementing an effective program.

2. Rapid decontrol of oil and gas prices and abolition of entitlements are the most important ways of providing needed incentives to displace oil imports by inducing real conservation and increasing supply. Equity concerns, such as undue burdens on people with low incomes, should be dealt with by transfer payments rather than by manipulating prices or by allocations.

3. Environmental laws should be administered and perhaps amended to encourage energy production as well as to protect the environment.

4. Licensing for operation of completed nuclear plants should be expedited in order that the plants may be put in production immediately. Partially

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completed power plants (both coal and nuclear) should be completed on an accelerated schedule. Unnecessary regulatory impediments to other energy facilities (such as pipelines, port facilities and drilling platforms) should be removed.

5. Oil for non-transportation uses should be promptly replaced by natural gas and coal and nuclear generated electricity. Limitations on production and use of natural gas and electricity should be reduced to permit price competition to determine their relative market shares. Electric utility rates should reflect the marginal costs of new power plants.

6. The energy industries should with government encouragement jointly prepare emergency plans against an oil cutoff. Among other measures, acquiring spare production and storage capacity should be encouraged.

7. The automotive industries should be encouraged to increase their efforts to produce more fuel efficient automobiles, including electrical and hybrid vehicles.

8. Contingency plans should be made to curtail energy consumption, and to temporarily suspend some procedural requirements and environmental standards, in the event of an oil cutoff. Wide public discussion of these plans at the community and the factory levels should be inaugurated.

9. In addition to the present US 90-day commercial oil reserve, a Strategic Petroleum Reserve should be accumulated at a rate of more than 300,000 barrels per day. If it were possible to fill it at a rate of one million barrels per day, an amount of oil necessary to supply the economy with six million barrels per day (the maximum projected deficit) for four months would be accumulated in two years.

10. Since the use of oil in Western Europe & Japan for generating electricity is about three million barrels per day, it is in the interest of the US to reduce their vulnerability by encouraging and assisting their conversion to nuclear energy and coal.

RAW MATERIALS

URANIUM PROVINCE OF NIGER

Introduction

Uranium was first discovered in the Air region of The Republic of Niger in 1957. During the ensuing years, additional ore discoveries were made and a producing industry developed. The Air region of Niger is presently one of the world's important uranium provinces. Its uranium resources are roughly estimated at 100,000 to 200,000 tonnes U.

The discovery of large stratiform uranium deposits has been limited to the Air region where the geology and mode of uranium occurrence is comparable to the Grants uranium district of New Mexico. The area lies within the depositional transition zone of marine sedimentation from the north and continental sedimentation from the south, and includes local Precambrian highlands. The important uranium mineralization occurs in continental sediments of Carboniferous and Jurassic age. Geologically, the entire north and central areas of Niger are also favorable for uranium occurrences.

Geologic History

The interpretation of the geologic history of Africa led to the identification of potential exploration areas and eventually to uranium discoveries in Niger and elsewhere in Africa. The interpretation still remains valid today, and is used as an aid in the initiation of exploration projects, especially in frontier areas.

Generally, the geology of Africa indicates that the entire continent has remained relatively stable since Precambrian time. However, during Precambrian time, the continent was subjected to major tectonic events of mountain building and the formation of structurally related intracontinental basins. The northern portion of the continent became tilted downward toward the north, probably as the result of regional subsidence and down-warping associated with early movement along the Mediterranean tectonic belt.

Post Precambrian activity saw the beginning of a long period of erosion and fluvial deposition. Subsequently a thick accumulation of stream sediments was deposited in the basin areas throughout the continent. The low area in the north was intermittently invaded by transgressive epicontinental seas, resulting in the deposition of thick marine sediments which spread southward into what is now Niger. Marine deposition continued throughout the Lower Cretaceous Period; continental deposition continued through the late Tertiary.

Sandstone facies of continental sediments throughout Africa are potentially favorable hosts for uranium occurrences. In fact, stratiform accumulations of uranium in sandstone are known to occur in Algeria, Gabon, the Central African Republic, Zambia, South Africa and Niger. Promising indications of mineralization are being evaluated in these countries as well. However, the only stratiform deposits being mined at this time are in Niger and Gabon.

Uranium Geology

Uranium exploration in Niger was initiated by the French Commissariat a l'Energie Atomique (CEA) in the Air region during 1954. Airborne and ground radiometric surveys were successful in the discovery of numerous radioactive anomalies during the following three years. Certain anomalies were evaluated in detail, and drilling for subsurface mineralization was done in some cases. The first significant uranium discovery was made in 1957. The CEA recognized the potential of the Air region and has since concentrated exploration in the Agadez Basin, an isolated structure within the vast Iullemeden Basin. Other exploration groups taking up prospecting permits in Niger have likewise concentrated their interest in the Agadez Basin, although prospecting has spread to other areas within the Iullemeden Basin.

The Iullemeden Basin is bordered to the east and north by Precambrian crystalline rocks of the Air and Hoggar Mountains respectively, by crystalline rocks of the Eburnean highland to the soutwest, the Chad Basin to the east, and the Taodeni Basin to the west. The Iullemeden Basin is filled with fine to coarse clastic, continental sediments interbedded with mudstones, volcanic ash and tuffs. The age of the rocks ranges from Carboniferous to Cretaceous.

The Agadez Basin lies immediately west of the Air Mountains. The principal uranium host formations consist of fluviatile to near-marine sandstones of various geologic age within the sedimentary sequence filling the basin. The uranium deposits at Arlit, Akouta and Madouela occur in Carboniferous rocks, the Azelik deposit in Premian-Triassic rocks, and the Imouraren deposit in Jurassic rocks. In all the deposits, coffinite and pitchblende are the only uranium minerals present.

The formations filling the Agadez Basin dip gently from the Air Mountains. Toward the western part of the basin, the formations are uplifted by the Arlit fault, a major north-south structural feature which bisects the basin. The sediments are further displaced by minor northeast-southwest trending faults. Known ore deposits appear to be related to the faulting. In fact, the major ore deposits are located immediately east and parallel to the Arlit fault. Present exploration activity is therefore concentrated in areas with similar geologic characteristics. There are at least 10 exploration and mining projects in Niger at this time.

Exploration of Agadez Basin

Local interpretation of the basin geology has required the application of sophisticated exploration techniques. Each discovery of mineralization has given rise to new geologic and exploration ideas, all of which were important to the eventual discovery of additional ore deposits. Essentially all exploration techniques developed for the Agadez district are applicable to exploration of continental sediments throughout Africa.

The CEA intensified its exploration activities after the first discovery in 1957. Subsequently, 65 radiometric anomalies were discovered by airborne methods; visible uranium mineralization was noted on 18 of the anomalies. The Azelik structure was identified as a strong anomaly and systematically prospected in 1959, resulting in the discovery of the first important uranium deposit in Niger. Uranium mineralization of primary importance was found in a Carboniferous sandstone on both sides of a secondary northeast trending fault. Uranium of secondary importance was found in channel-filling Cretaceous sandstone, west of the fault.

Table 8 contains a breakdown of participation in the various exploration and mining operations in The Republic of Niger. The Azelik deposit has been through at least two major exploration phases. The CEA core drilled a total of over 14,000 feet before conceding in 1971 that there was insufficient tonnage in the deposit for commercial development. Later, additional drilling resulted in the location of two deposits containing approximately 12,000 tonnes U.

The Madouela deposit was disocvered by the CEA in 1962. Mineralization was found associated with basal paleochannel sands and conglomerates of the Guezouman formation overlying the black shales of the Talak Formation, both Carboniferous in age. The channel was delineated for about five miles down-dip from a northeast-southwest fault. Two separate ore deposits were drilled out—the Marianne and Marylin. Additional evaluation drilling in 1964 was successful in proving ore reserves of about 6,200 tonnes U. Reserves were considered insufficient for profitable mining at that time. The deposits are now included in a new prospecting permit area, referred to as Afasto Est.

The Arlit deposit was discovered by the CEA in 1965. Again, mineralization was found in the basal Guezouman Formation, and in the younger Tarat-Madaouela Formation. Detailed exploration resulted in the discovery of three separate ore deposits with estimated total reserves of 22,000 tonnes U. The Arlette ore deposit was put into production by Somair in 1970, and first mill production began in 1971. The Arlette deposit has since been mined out and the Ariege deposit is now being mined. The Artois deposit is in the early stages of development and will be brought into production as the Ariege deposit is phased out. The predominant uranium mineral in the three deposits is coffinite. The main accessory mineral is pitchblende.

The Akouta deposit was discovered in 1966, also by the CEA, about 10 km south of Arlit. A total of 105 holes were drilled to an average depth of 860 feet during the next three years. Mineralization was discovered in basal channel units of the Tarat and Guezouman formations, as at Arlit. Ore reserves are estimated at 40,000 tonnes U. Coffinite and pitchblende are the predominant uranium minerals present. Underground mining of the Akouta deposit began in early 1978; mill production began in August, 1978 at a rate of 2,000 tonnes ore per day.

The Arni deposit was discovered by the CEA about four km southwest of the Arlit deposits in 1969. Ore reserves have been estimated at 20,000 tonnes U. A project feasibility study was recently completed, and detailed engineering studies are now in progress. It appears that ore can be mined by open pit methods.

The Imouraren deposit was discovered about 80 km south of Arlit by the joint venture of Onarem, Cogema and Conoco in 1967. Ore grade mineralization was found in three different sandstones of Jurassic age. The host rock is channel-filling, coarse sandstone associated with interbedded mudstone. The upper ore zone is at an average depth of 350 feet. The

Table 8
ACTIVE EXPLORATION AND MINING PROJECTS IN THE REPUBLIC OF NIGER

Project Designation	Participants	Percentage Held
1. Azelik	Onarem (Niger)[1]	50%
	IRSA (Japan)	50%
2. Madaouela Afasto-Est	Onarem	30%
	Cogema (France)	30%
	Nigeria	16%
	CEGB (UK)	12%
	Saarberg Interplan (FRG)	12%
3. Arlit (Societe des Mines de l'Aire—Somair)	Onarem	33.0 %
	Cogema	19.96%
	CFMU (France)	11.80%
	Minatome (France)	7.58%
	Mokta (France)	7.58%
	Urangesellschaft (FRG)	6.54%
	Agip (Italy)	6.54%
4. Akouta (Compagnie Miniere d'Akouta—Cominak)	Onarem	31%
	Cogema	34%
	OURD (Japan)	25%
	Enusa (Spain)	10%
5. Arni (Societe Miniere de Tassa N'Taghalque—SMTT)	Onarem	50%
	Cogema	50%
6. Imouraren	Onarem	30%
	Cogema	35%
	Conoco (US)	35%
7. Afasto-Ouest	Onarem	37.5%
	Cogema	37.5%
	OURD	25.0%
8. Djado Basin	Onarem	50%
	Pan Ocean Oil (Canada)	50%
9. In-Adrar	Onarem	33%
	Cogema	26%
	AEOI (Iran)	26%
	Agip	15%
10. Aracca-Oxoco	Onarem	50%
	Aracca-Oxoco	50%

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[1] ONAREM—Office National des Resources Miniere—a national company established by the Ministry of Mines and Water Resources of the Republic of Niger.

predominant mineral is coffinite. Ore reserves have been estimated at about 66,000 tonnes U, making it the largest single uranium deposit in Niger. The project is in an advanced stage of engineering. Indications are that a production rate of 3,000 tonnes U per year could be attained from large scale open pit mining and conventional milling.

Several uranium occurrences in the Afasto-Ouest permit area are currently being evaluated. The area is located southwest of Akouta. Geologically, the prospects are favorably located on an apparent extension of the Akouta ore trend, but on the west side of the Arlit fault. The Mineralization is at a depth of 750 feet—the deepest ore to be considered for development.

Other exploration projects are going ahead in Djado Basin and along the Algerian border. The In-Adrar concession, south of Imouraren, and the Aracca-Oxoco concession in southern Niger are inactive. Figure 4 shows the approximate location of the uranium deposits of The Republic of Niger.

Production

Uranium production totaled about 3,500 tonnes U (about 9,100,000 pounds U_3O_8) from the Arlit and Akouta projects in 1979. Annual production is scheduled to expand to 2,300 tonnes U at Arlit and 2,200 tonnes U at Akouta to bring total annual production capacity up to 4,500 tonnes U by the end of 1981. However, both expansion programs are behind schedule and the 1981 completion date may not be attainable.

The program to expand production at the two producing mines and the start-up of new mines was included as a basic economic consideration in the Niger government's Five-year Development Plan for the period 1979 through 1984. The fact that expansion plans are behind schedule at a time when the world uranium market is in disarray, will not doubt require thoughtful planning to preserve a developing industry that presently accounts for almost 75 percent of Niger's export trade.

Mineral Resource Policy

The government of Niger realized the economic potential of uranium development in the early days of prospecting. The government formed a national company—the Office National des Ressources Miniere (Onarem)—to coordinate all activities in exploration, exploitation and marketing of minerals within the Republic of Niger. Under its charter, Onarem can conduct independent exploration programs, and can participate in all exploration or mining activities in Niger. In this capacity, it holds title to the government interests in uranium projects and acts as the commercial partner in exploration and mining ventures.

Under the Niger Mining Law of 1961, all mineral activities are regulated as follows:

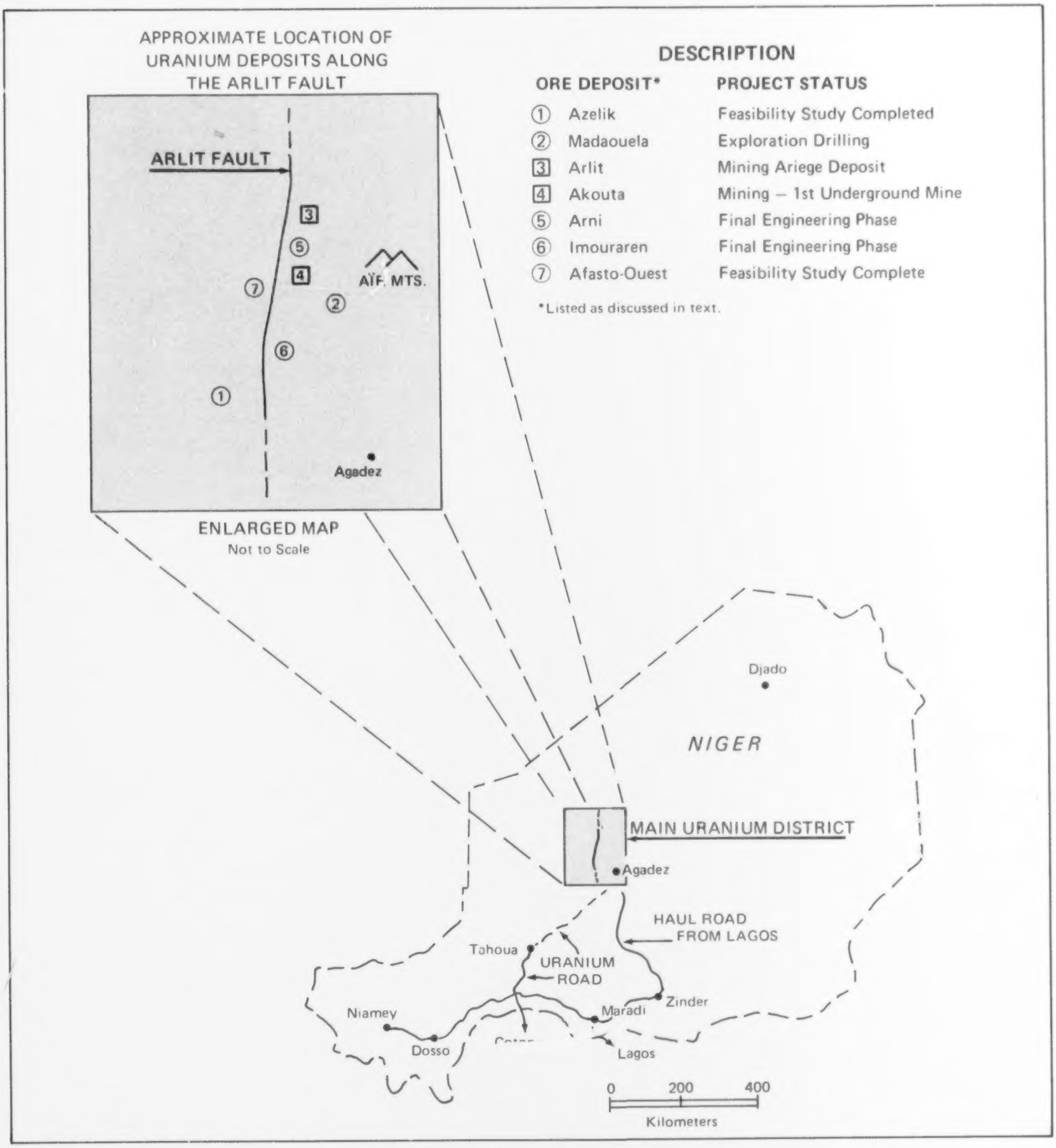
- Prospecting permit is required before any work is performed. The term is six months to four years. It can be renewed twice for four years each.
- Exploration permit issued to parties capable of performing minimum requirements for specified area. The term is five years with two five-year renewals allowed. There are two types of permit. Type A covers large permit areas, one-half of which must be relinquished at first renewal, up to a quarter of remaining area at second renewal. Type B permit is issued on small tracts with no relinquishment required.
- Exploitation permit is granted for an exploitable mineral deposit located within the exploration permit area. Term is four years with four renewals possible.
- Mining concession is issued for large, exploitable mineral deposit. Technical and financial qualifications must be demonstrated to satisfaction of government. Term is 75 years with one or more renewals of 20 years as long as exploitation continues.

The Mining Law requires payment of a nominal fee at the time a permit is issued. Annual rental payments, based upon area, are required. The Law further provides that the government of Niger will obtain a free economic interest in all permits or concessions issued.

The business activities of uranium companies are regulated by a tax law enacted in 1968. The law imposes a 1% ad valorem tax on concentrates exported, a 4.5% ad valorem royalty on the mine value of concentrates in addition to the regular 40.5% tax on profits, and 16% tax on revenue derived by transferring securities. The law provides for allowable deductions and certain exemptions from turnover taxes and customs duties.

The mining and tax laws form the basis on which long term conventions can exist between companies and the government of Niger. These conventions de-

RAW MATERIALS


APPROXIMATE LOCATION OF URANIUM DEPOSITS ALONG THE ARLIT FAULT
ARLIT FAULT
3
⑤
4
⑦
AÏR MTS.
②
⑥
①
Agadez
ENLARGED MAP
Not to Scale
Djado
NIGER
MAIN URANIUM DISTRICT
Agadez
HAUL ROAD FROM LAGOS
Tahoua
URANIUM ROAD
Zinder
Maradi
Niamey
Dosso
Cotonou
Lagos
0
200
400
Kilometers

DESCRIPTION

ORE DEPOSIT*		PROJECT STATUS
①	Azelik	Feasibility Study Completed
②	Madaouela	Exploration Drilling
3	Arlit	Mining Ariege Deposit
4	Akouta	Mining – 1st Underground Mine
⑤	Arni	Final Engineering Phase
⑥	Imouraren	Final Engineering Phase
⑦	Afasto-Ouest	Feasibility Study Complete

*Listed as discussed in text.

Figure 4
LOCATION MAP OF KNOWN URANIUM DEPOSITS IN THE ARLIT DISTRICT, REPUBLIC OF NIGER

BEST AVAILABLE COPY

fine the rights and obligations of the parties. A foreign company or a foreign-controlled Nigerien company can do business in Niger, but it must obtain permission to do so.

Transportation

Transportation facilities—or lack of facilities—is one of the most perplexing problems confronting active uranium groups in Niger. There was virtually no road system in the Agadez region when the CEA entered the area in the 1950's. Twenty-five years later, a road system is beginning to develop, but problems still exist. There are no railroads in Niger. The lack of an adequate road and rail system contribute substantially to overall production costs.

The government is implementing a plan to ease the transportation problems. Truck shipments travel by way of an existing road from the town of Dosso via Tahoua and Agadez to Arlit. The road has been rebuilt as an all-weather road to Tahoua. The 650 km stretch of dirt road from Tahoua to Agadez and on to Arlit is presently being rebuilt as an all-weather road and should be completed in 1981 or early 1982. Construction of the "Uranium Road," as it is called, is being financed through loans from companies active in exploration and mining in Niger. Loan repayment will take place over a 20 year period, via a "Road Tax" on all uranium exported from Niger.

STATISTICAL DATA

EXCHANGE VALUE—31.50/lb U_3O_8
Determined as of July 31, 1980

Definition

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of July 31, 1980

$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
37.30	4.3	19	6

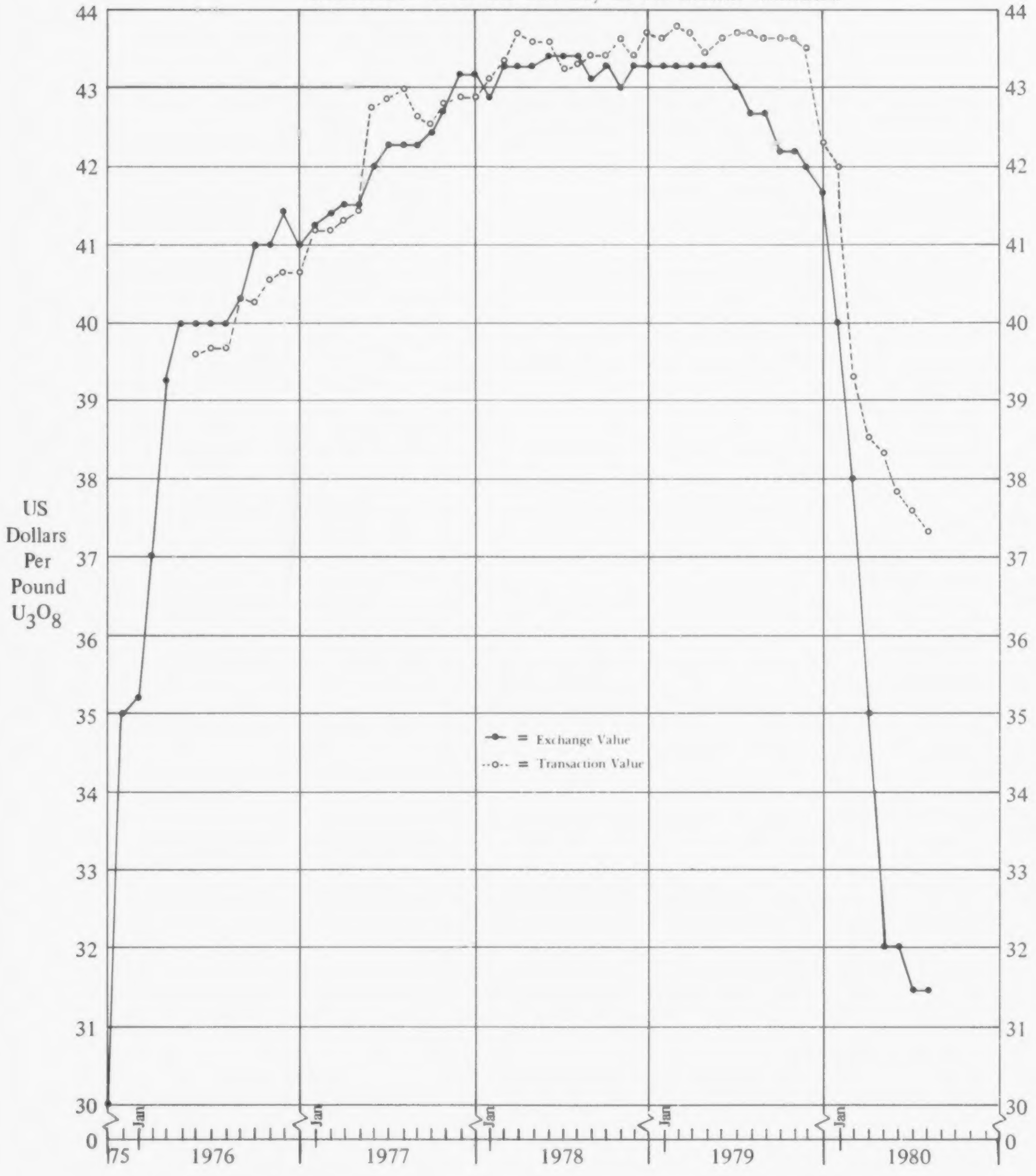
Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES SINCE NOVEMBER 1975

Determined as of the last day of the month indicated



STATISTICAL DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated

(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50					

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated

(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30					

Note: See Nuexco Report 135 for a discussion of the definition of Transaction Value.

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	31.50	69.45	81.89
France (franc)	127.02	280.02	330.21
FRG (mark)	54.68	120.54	142.15
Japan (yen)	7,033	15,505	18,284
Switzerland (franc)	50.25	110.78	130.63
UK (pound)	13.15	29.00	34.19
Australia (dollar)	27.11	59.76	70.48
Canada (dollar)	36.34	80.13	94.49
Niger, Gabon (CFA)	6,351	14,001	16,511
South Africa (rand)	23.97	52.85	62.32

*Calculated using currency exchange rates published in the Wall Street Journal on the last Friday of the month.

LOAN USE CHARGE RATE—7.0%/year

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Nuexco Reference Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as percent of Current E.V.	Seller Group	Buyer Group	Remarks
1154	80	100 – 300	99	US	Europe	
1155	80	50 – 100	–	US	Other	Enriched UF_6; definitive price info not available
1156	80	50 – 100	103	Canada	Canada	Not arms-length
1160	81	100 – 300	99	US	Europe	UF_6
1164	82-90	4000 – 7000	–	Australia	US	Definitive price info not available
1165	80	100 – 300	–	US	US	UF_6 loan; return in 1983
1166	81	100 – 300	–	US	US	UF_6 loan; return in 1983
1169	80	Less than 50	98	US	US	

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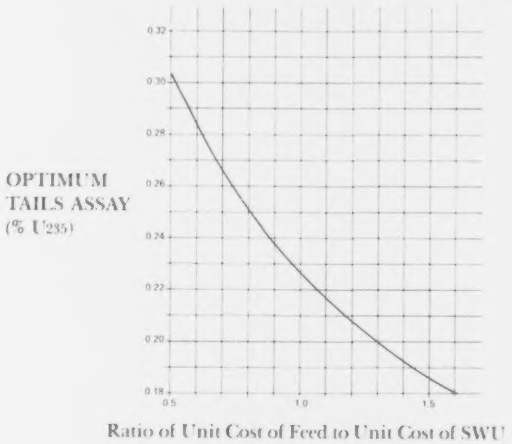
*Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

OPTIMUM TAILS ASSAY

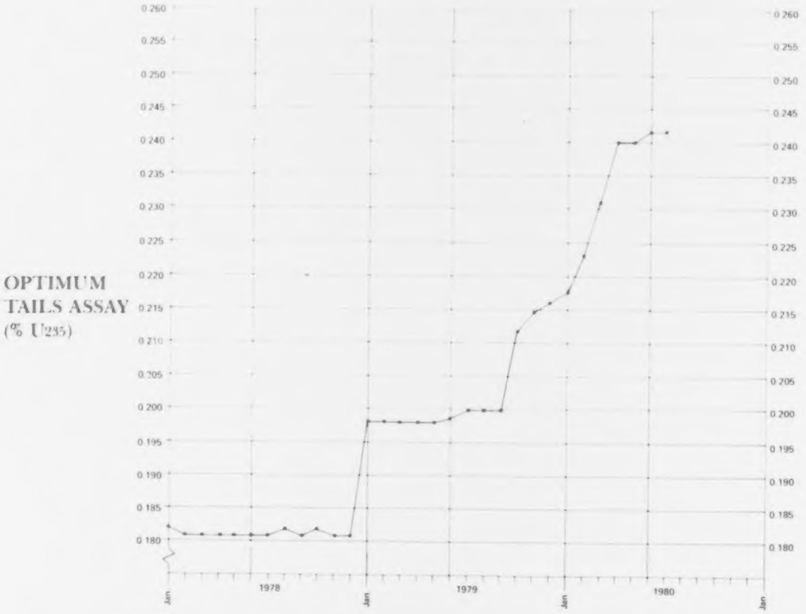
The optimum tails assay is the tails composition at which the cost of enriched uranium is lowest for given costs of separative work (SWU) and natural uranium feed. It depends only on the ratio of the cost of a kilogram of natural uranium in the form of UF_6 to the cost of a kilogram unit of separative work. The US Department of Energy (USDOE) Adjustable Fixed Commitment (AFC) enrichment contract holders have the option, within limits, to specify the transaction tails assay. The transaction tails assay for USDOE Requirements contracts is 0.2 percent U_{235}. For every one-hundredth of one percent increase in the transaction tails assay, uranium consumption increases about two percent.

TAILS ASSAY FOR MINIMUM COST OF PRODUCT*



*From Nuexco Report 138

HISTORICAL OPTIMUM TAILS ASSAY[1]



[1] Based on Exchange Value and USDOE AFC SWU price; interpolated to the nearest thousandth.

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 199)[1]	Consumer Price Index (1967 = 100)[2]	GNP Implicit Price Deflator (1972 = 100)[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]		
				Metal Mining (SIC 10)	**Primary Non-ferrous Metals (SIC 333)**	**Chemicals and Allied Products (SIC 28)**
Annual Avg. 1970 (5)	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971 (5)	114.1	121.3	96.02	4.12	4.15	3.97
Annual Avg. 1972 (5)	117.9	125.3	100.00	4.56	4.59	4.26
Annual Avg. 1973 (5)	125.9	133.1	105.80	4.84	4.98	4.51
Annual Avg. 1974 (5)	153.8	147.7	116.02	5.44	5.63	4.88
Annual Avg. 1975 (5)	171.5	161.2	127.15	6.13	6.24	5.39
Annual Avg. 1976 (5)	182.4	170.5	133.71	6.76	6.87	5.91
Annual Avg. 1977 (5)	195.1	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978 (5)	209.4	195.4	152.05	8.23	8.56	7.01
Annual Avg. 1979	236.5	217.4	165.46	9.27	9.50	7.59
Apr 1979	229.0	211.5		9.03	9.49	7.50
May 1979	231.6	214.1	—	9.06	9.15	7.47
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9	—	9.32	9.57	7.60
Aug 1979	240.6	221.1	—	9.38	9.70	7.65
Sep 1979	244.2	223.4	167.20	9.63	9.79	7.73
Oct 1979	249.0	225.4	—	9.67	9.87	7.82
Nov 1979	250.6	227.5		9.79	9.86	7.87
Dec 1979	253.1	229.9	170.58	9.80	9.92	7.91
Jan 1980	260.3	233.2	—	9.92	10.06	7.96
Feb 1980	265.4	236.4	—	9.93	10.01	7.99
Mar 1980	268.2	239.8	174.48R	9.91	10.23	8.04
Apr 1980	270.7	242.5	—	10.00	10.30	8.12
May 1980	271.2	244.9	—	10.12P	10.37P	8.16P
Jun 1980	273.0	247.6	—	—	—	8.24P

P = Preliminary R = Revised since last month

(1) US Bureau of Labor Statistics, Washington, D.C.: "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. All data for 1977 and beyond are adjusted to the most recent benchmark—March 1978—and are subject to revision from that point forward, with the advent of the next benchmark scheduled for publication in late 1980.

(5) Data for 1970-1978, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Nuexco Report 139.

STATISTICAL DATA

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry—All Groups (Year 1968-69 = 100.0)[1]	Weighted Average Minimum Weekly Wage Rates—Adult Males Australia Mining and Quarrying (A$)[2]
Annual Avg. 1970 (3)	101.4	59.88
Annual Avg. 1971 (3)	101.5	65.95
Annual Avg. 1972 (3)	105.6	71.26
Annual Avg. 1973 (3)	124.4	78.96
Annual Avg. 1974 (3)	141.9	108.07
Annual Avg. 1975 (3)	150.4	132.55
Annual Avg. 1976 (3)	168.4	160.93
Annual Avg. 1977 (3)	192.0	179.03
Annual Avg. 1978 (3)	215.4	190.04
Annual Avg. 1979	248.5	196.34
Feb 1979	253.0	190.19
Mar 1979	264.0	191.64
Apr 1979	274.0R	192.46
May 1979	288.5R	193.56
Jun 1979	294.9R	196.64
Jul 1979	298.2R	199.22
Aug 1979	293.2R	200.29
Sep 1979	302.4R	201.07
Oct 1979	309.4R	200.53
Nov 1979	310.4R	199.84
Dec 1979	319.4R	200.65
Jan 1980	340.1R	215.31R
Feb 1980	345.6	214.78R
Mar 1980	340.3P	214.22R
Apr 1980	326.6P	214.53
May 1980	—	214.07P

P = Preliminary R = Revised since last month

(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.
(2) Australian Bureau of Statistics, Canberra; "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest fourteen months shown are subject to revision.
(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Nuexco Report 138.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000)[1,2] (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings (C$)[3,4]		
		Metal Mining, including milling (SIC 050-059)	Primary Metal Industries, non-ferrous (SIC 296-298)	Chemicals and Chemical Products (SIC 370-379)
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Annual Avg. 1979	217.9	9.60	7.35	7.67
Mar 1979	210.4	9.47	7.20	7.51
Apr 1979	212.8	9.68	7.26	7.63
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3	9.37	7.34	7.73
Aug 1979	220.0	9.56	7.38	7.77
Sep 1979	223.4	9.75	7.50	7.81
Oct 1979	227.4	9.89	7.54	7.88
Nov 1979	228.1	9.97	7.61	7.91
Dec 1979	230.4	9.93	7.51	7.89
Jan 1980	238.9R	9.96	7.57	7.99
Feb 1980	240.6	10.11	7.69	8.08
Mar 1980	239.4R	10.34P	7.83	8.26P
Apr 1980	240.8	10.37P	7.94P	8.33P
May 1980	242.8P	—	—	—

P = Preliminary   R = Revised since last month

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 4.10 of Nuexco Report 138.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 4.11 of Nuexco Report 138.

STATISTICAL DATA

REPUBLIC OF SOUTH AFRICA STATISTICS

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100, except where otherwise indicated)
Annual Avg. 1970 (3)	7.34	100.3 (4)
Annual Avg. 1971 (3)	7.88	106.4 (4)
Annual Avg. 1972 (3)	8.79	113.3 (4)
Annual Avg. 1973 (3)	10.51	124.1 (4)
Annual Avg. 1974 (3)	13.18	138.5 (4)
Annual Avg. 1975 (3)	16.71	157.2 (4)
Annual Avg. 1976 (3)	19.30	174.7 (4)
Annual Avg. 1977 (3)	23.87	194.4 (4)
Annual Avg. 1978 (3)	27.14	137.2
Annual Avg. 1979 (3)	30.18	155.3
Apr 1979	–	149.9
May 1979	–	150.6
Jun 1979	29.44	152.4
Jul 1979	–	157.9
Aug 1979	–	160.2
Sep 1979	30.71	162.1
Oct 1979	–	162.9
Nov 1979	–	163.4
Dec 1979	31.89	164.0
Jan 1980	–	165.4
Feb 1980	–	167.0
Mar 1980	33.65	168.0
Apr 1980	–	170.0
May 1980	–	171.9
Jun 1980	–	174.6

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(1) Chamber of Mines of South Africa, Johannesburg: "Analysis of Working Results," published quarterly.

(2) Republic of South Africa Department of Statistics, Pretoria: "Government Gazette: Consumer Price Index for Urban Areas."

(3) Historical data for 1970 through 1979 appear on page 4.9 of Nuexco Report 140.

(4) April 1970 = 100.00

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM SUPPLY

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8) 1980	1981	1982	1983	Remarks
Available for Sale:					
1213	150				
1236			150	150	
1274	150				
1284	250				
1286		150	150	150	
1315			200	200	
1325	750				
1338	250				
1346	200				
1392	300				
1394	250				
1465	25				
1475	1000				UF_6
TOTALS	3325	150	500	500	
Available for Loan:					
1175	700				UF_6
1234	700				
1354	600				UF_6
1355	600				
1429	500				
TOTAL	3100				

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM DEMAND

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8)				Remarks
	1980	1981	1982	1983	
Inquiries to Purchase:					
1146		100	200	200	
1406	50				
1408	150				
1410		2000	2000	2000	
1459			200	200	
1462				100	
1468		1000			
1470	25				
TOTALS	225	3100	2400	2500	
Inquiries to Borrow:					
1220	500				

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the secondary market for UF_6 conversion services. The data presented in this section are in no way intended to be indicative of the entire market for the time period covered.

CONVERSION SUPPLY

Nuexco Reference Number	**Delivery Period (Thousands of Pounds U as UF_6)**				**Remarks**
	1980	**1981**	**1982**	**1983**	
P-1282	250	250			
P-1424	1000				
P-1449		750			
P-1450	750				
P-1451	175				
P-1474	50				Non-U.S.
TOTALS	2225	1000			

CONVERSION DEMAND

Nuexco Reference Number	**Delivery Period (Thousands of Pounds U as UF_6)**				**Remarks**
	1980	**1981**	**1982**	**1983**	
P-1424-A	190				

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NUEXCO

SEPTEMBER 1980 NUMBER 145

Monthly Report on the Uranium Market

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NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

September 1980 No. 145

JAMES E. VAUGHAN, *EDITOR*

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FOREWORD

We are delighted to announce that Mr. R. K. (Dick) Andersen is joining Nuexco this month as Vice President and Senior Consultant. Dick will develop a consulting division to complement our information services and brokerage activities. Nuexco has been passive about accepting special consulting assignments in the past. However, the large number of requests from Subscribers for us to provide this type of service has led us to change this position.

Dick Andersen began his career in the nuclear power industry in 1950 with the General Electric Company at the Hanford works. He transferred to the Company's commercial nuclear division in San Jose, California, in 1955. From 1968 to 1976, he was a partner in a consulting business, with his area of responsibility that of uranium and the nuclear fuel cycle. In 1976, he rejoined General Electric as a senior member of its strategic planning operations.

URANIUM MARKET

GENERAL

Supply and Demand Balance

In Report 142, Nuexco published an analysis of world uranium supply and demand. The analysis concluded that:

1. *Firm supply* (defined as supply from uranium production centers operating or under construction) appeared more than sufficient to satisfy *consumption* (defined as uranium entering the enrichment-fabrication pipeline) on a worldwide basis through 1990.

2. In addition, firm supply appeared adequate to increase worldwide inventory levels to approximately 3.5 years of forward consumption by 1990.

In Report 144, Nuexco published revised estimates of apparent future consumption. Also this month's Report contains Nuexco's revised forecast of US uranium production. This section analyzes the resultant changes in the worldwide supply and demand balance, following some prefatory comments on definitions and computational groundrules.

1. Nuexco's estimates of apparent future consumption are sometimes confused with estimates of uranium burnup in reactors. Actually, apparent future consumption, as defined by Nuexco, is natural uranium concentrate which utilities would need to deliver in a given year for enrichment and fabrication and later use in a reactor. Thus, *consumption* is the fundamental component of uranium demand. These estimates apply only to the assumed pattern of additions to installed nuclear electric generating capacity, and they make no allowance for earlier or greater demand associated with contracts for conversion, enrichment or fabrication.

2. With respect to production outside the US, the critical assumption in this supply-demand analysis is that uranium production centers in operation or currently under construction will be able to sell their projected U_3O_8 output, even if only for inventory accumulation in a time of apparent excess supply.

3. With respect to US production centers, the critical element in this supply-demand analysis is the degree to which producers having existing contracts will elect to purchase rather than produce uranium.

4. To the extent that actual annual demand exceeds consumption, inventory is accumulated.

5. Planned production centers—those with production plans and identified ore reserves, but for which construction has not yet begun—are not considered in this analysis.

6. It is important to note that estimates of apparent future consumption take no account of reactors not yet ordered. Consequently, consumption estimates will understate actual demand by the amount attributable to orders yet to be placed, as well as by inventory purchases.

7. In order to facilitate understanding of the concept of apparent future consumption other aspects of Nuexco's methodology are summarized as follows:

a. Apparent future consumption should be regarded as a comparatively hard component of total demand, and is relatively insensitive to uranium prices. Market demand *for the assumed pattern of additions to nuclear electric generating capacity* can be higher, but is not likely to be much lower.

b. Actual demand can exceed apparent future consumption because of accelerated reactor construction schedules or inventory purchases by utilities.

c. Reactor loading is calculated for each reactor based on its individual core characteristics. It is assumed that: 1) U_3O_8 deliveries for first cores predate commercial operation by two years; 2) first reload occurs 12 months after commercial operating date and annually thereafter (in some cases, actual reload schedule is substituted for the assumed 12-month interval); 3) U_3O_8 delivery for each reload predates reload by 18 months.

d. Actual commercial operating dates can differ widely from published dates. Nuexco uses the best information available, much of it from unpublished sources.

e. Reactors fueled by the USSR are excluded.

8. Inventory refers to natural uranium inventory (U_3O_8 and UF_6) owned by utilities, reactor manufacturers, fuel fabricators and national organizations which procure uranium for commercial purposes. The inventory amounts do not include strategic stockpiles, such as those owned by the US Department of Energy (USDOE). Difficulties in accounting precisely for the variety of possible forms, locations and ownership of uranium inventory necessarily result in some uncertainty in estimating the total world natural uranium inventory. Nuexco's estimate of worldwide commercial natural uranium inventory as of the beginning of 1979 is approximately 160 million pounds; however, the uncertainty factor of this estimate is ten to fifteen percent. More important is the fact that the primary conclusions of this analysis are not sensitive to beginning inventory vari-

ations of ten to fifteen percent.

Analyses of the uranium supply and demand balance were conducted for each of the following regions: (1) world outside Communist areas (WOCA); (2) US; (3) non-US WOCA.

Table 1 tabulates Nuexco's analysis of the uranium supply and demand balance for the world outside Communist areas (WOCA). Conclusions which may be drawn from the analysis include the following:

1. Firm supply exceeds consumption in each year through 1990. Supply and demand can be balanced by additions to inventory. In actual practice, if supply exceeds demand over an extended period, the necessary balance would probably result from a combination of inventory purchases and reduced production.

2. The world inventory of 160 million pounds at the beginning of 1979 is equivalent to 2.3 years of forward consumption at the 1979 rate. The analysis indicates that the 1980 beginning inventory of approximately 190 million pounds will more than double by 1990, to approximately 385 million pounds U_3O_8 equivalent. That quantity corresponds to approximately 3.3 years forward consumption at the 1990 rate. In fact, the analysis indicates a very stable relative inventory level throughout the decade; each year's relative inventory level falls in the range of 3.1 to 3.3 years forward consumption.

The relative inventory level of approximately three years forward consumption represents a substantial increase over the data published just ten months ago in Nuexco Report 135. At that time, this same type of analysis indicated a fairly stable relative inventory level of 2.0 to 2.3 years forward consumption. The difference is almost solely attributable to the substantial reductions in Nuexco's estimates of apparent future consumption, which have taken place since then.

3. If actual demand is to be sufficient to support production from production centers planned, but not yet under construction, it may arise from new reactor orders, or from political or national policy considerations. However, it is more likely that the driving force behind any such additional production entering the market would be the displacement of other higher-cost production centers.

Table 2 shows Nuexco's current analysis of the uranium supply and demand balance for the US. By treating the US alone, the potential market can be identified not only for imports, but also for potential US production centers not yet under construction.

The anlaysis in Table 2 is of the same basic form described above, but with the addition of an adjustment for *firm* US export-import commitments. The result is an annual supply surplus or deficit for the US. If the annual result is a supply surplus, it is assumed to have been added to buyer inventories. If the annual result is a supply deficit, it is assumed to have been removed from buyer inventories. The annual beginning and ending inventory levels are also tabulated in Table 2 along with the relative inventory level for that year, in years of forward consumption. Table 2 indicates an annual US supply deficit beginning in 1983 and growing to an annual level of more than 25 million pounds by 1985. Without additional imports or new US supply, US inventory would decline to a level equivalent to 18 months forward consumption by 1986. Under the groundrules of this analysis, US inventories would be completely liquidated in 1988.

Based on these results, it appears that the US will be dependent to a large extent upon imported uranium by the mid-1980's. Thus it is likely that US users, as a group, will desire to maintain a commercial inventory of uranium. Tables 3 and 4 were developed under the assumption that US utilities would maintain a collective inventory level equivalent to at least 18 months foward consumption. The two most important assumptions in computing the data in Table 3 are as follows:

1. When, after taking into account exports, imports and annual consumption, annual US production is enough, or more than enough, to maintain inventory equivalent to 18 months forward consumption, any excess production will be added to inventory.

2. When, after taking into account exports, imports and annual consumption, annual US production is insufficient to maintain inventory equivalent to 18 months forward consumption, US buyers will acquire the additional uranium through some combination of increased imports, increased purchases from US facilities operating or under construction, and purchases from new US production centers not yet under construction.

If, as assumed in Table 3, US buyers maintain a

URANIUM MARKET

Table 1
NATURAL URANIUM SUPPLY-DEMAND BALANCE: WOCA[1]
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[2]												
Operating Production Centers	98.5	103.3	105.8	104.3	104.8	104.1	101.1	100.1	99.2	99.0	99.0	99.0
Facilities under Construction	-0-	0.6	6.4	8.9	12.9	17.7	19.8	20.8	20.6	20.6	20.6	20.6
Total	98.5	103.9	112.2	113.2	117.7	121.8	120.9	120.9	119.8	119.6	119.6	119.6
less												
CONSUMPTION[3]	68.7	57.7	74.1	85.3	93.9	100.2	113.4	112.5	113.7	114.1	115.0	114.1
equals												
NET INVENTORY INCREASE	29.8	46.2	38.1	27.9	23.8	21.6	7.5	8.4	6.1	5.5	4.6	5.5
plus												
BEGINNING INVENTORY	160.0[4]	189.8	236.0	274.1	302.0	325.8	347.7	354.9	363.3	369.4	374.9	379.5
equals												
ENDING INVENTORY	189.8	236.0	274.1	302.0	325.8	347.4	354.9	363.3	369.4	374.9	379.5	385.0
RELATIVE INVENTORY[5] (yrs)	2.3	3.3	3.2	3.2	3.2	3.3	3.1	3.2	3.2	3.3	3.3	3.3

[1] World outside Communist areas.
[2] This Report, Table 9.
[3] Natural uranium entering enrichment-fabrication pipeline for later use in a reactor. Nuexco Report 144, Table 1.
[4] Nuexco Estimate.
[5] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Table 2
NATURAL URANIUM SUPPLY-DEMAND BALANCE: US
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[1]												
Operating Production Centers	37.0	34.2	29.3	26.0	24.7	22.0	19.0	17.1	16.3	16.2	16.2	16.2
Facilities Under Construction	-0-	0.3	2.0	2.5	2.7	3.0	3.0	3.0	2.8	2.8	2.8	2.8
Total	37.0	34.5	31.3	28.5	27.4	25.0	22.0	20.1	19.1	19.0	19.0	19.0
less												
CONSUMPTION[2]												
Reactors Now Operational	16.3	17.4	17.4	17.1	18.0	18.0	18.1	17.4	17.6	18.3	18.2	17.7
Now Under Construction	8.5	0.7	7.5	12.8	17.2	22.2	25.4	30.0	27.1	30.3	27.2	27.6
Now On Order	-0-	-0-	-0-	-0-	-0-	-0-	-0-	0.9	0.3	0.3	3.4	2.0
Total	24.8	18.1	24.9	29.9	35.2	40.2	43.5	48.3	45.0	48.9	48.8	47.3
plus												
NET IMPORTS (EXPORTS)[3]	(1.8)	(1.9)	0.3	1.5	1.2	1.7	0.1	0.6	0.6	0.6	1.0	1.1
equals												
SUPPLY SURPLUS (DEFICIT)	10.4	14.5	6.7	0.1	(6.6)	(13.5)	(21.4)	(27.6)	(25.3)	(29.3)	(28.8)	(27.2)
plus												
BEGINNING INVENTORY	66.4[4]	76.8	91.3	98.0	98.1	91.5	78.0	56.6	29.0	3.7	-0-	-0-
equals												
ENDING INVENTORY	76.8	91.3	98.0	98.1	91.5	78.0	56.6	29.0	37.0	-0-	-0-	-0-
RELATIVE INVENTORY (yrs)[5]	2.7	4.2	3.7	3.3	2.8	2.3	1.8	1.2	0.6	0.1	-0-	-0-

[1] This Report, Table 7.
[2] Nuexco Report 144, Table 1.
[3] Nuexco Report 142, Table 3.
[4] George F. Combs, Jr.: "The US Uranium Market—1978-1979" USDOE; Grand Junction, Colorado; October, 1979.
[5] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

minimum inventory level of 18 months forward consumption, an *unfilled US demand* would be created as follows (millions of pounds U_3O_8):

	1985	*1986*	*1987*	*1988*	*1989*	*1990*
Annual	15.9	22.6	31.2	29.2	26.6	28.2
Cumulative	15.9	38.5	69.7	98.8	125.4	153.6

Thus, if US buyers' inventory policies take the form assumed in Table 3, the cumulative market for imports and new additions to US production will total approximately 150 million pounds U_3O_8 through 1990. This figure is essentially the same as the previous Nuexco estimate, published in Report 142. This is because the decreases in Nuexco's estimates of US apparent future consumption have been largely offset by decreases in Nuexco's estimates of US production.

If the US imports an additional 150 million pounds U_3O_8 through 1990, the effect on the rest of the world's uranium supply and demand balance could be substantial. Table 4 was developed to estimate this effect. Table 4 tabulates the supply-demand balance of the world outside the US and outside Communist areas, under the assumption that the US will import as necessary to maintain at least 18 months forward consumption in inventory. The analysis indicates an increase in relative inventory level from 2.9 years at the beginning of 1980 to almost five years by 1990. Even after projected exports to the US are deducted from production, there is a substantial supply surplus in each year through 1990. This analysis shows inventories outside the US nearly tripling, from approximately 113 million pounds in 1980 to 313 million pounds in 1990.

The conclusions to this analysis are similar to those of Report 142, namely that the additional delays and cancellations of reactor projects combined with apparently ample future uranium availability are leading to an increasingly competitive uranium market.

Table 3

NATURAL URANIUM SUPPLY-DEMAND BALANCE: US
(Assumes US Buyers Maintain At Least 18 Months Forward Consumption in Inventory)
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
CONSUMPTION[1]	24.8	18.1	24.9	29.9	35.2	40.2	43.5	48.3	45.0	48.9	48.8	47.3
CONSUMPTION x 1.5	37.2	27.2	37.4	44.9	52.8	60.3	65.3	72.5	67.5	73.4	73.2	71.0
MINIMUM ENDING INVENTORY[2]	27.2	37.4	44.9	52.8	60.3	65.3	72.5	67.5	73.4	73.2	71.0	72.0
BEGINNING INVENTORY	66.4[3]	76.8	91.3	98.0	98.1	91.5	78.0	72.5	67.5	73.4	73.2	71.0
plus												
ANNUAL SUPPLY SURPLUS (DEFICIT)[4]	10.4	14.5	6.7	0.1	(6.6)	(13.5)	(21.4)	(27.6)	(25.3)	(29.3)	(28.8)	(27.2)
equals												
NOMINAL ENDING INVENTORY[5]	76.8	91.3	98.0	98.1	91.5	78.0	56.6	44.9	42.2	44.1	44.4	43.8
UNFILLED DEMAND[6]	-0-	-0-	-0-	-0-	-0-	-0-	15.9	22.6	31.2	29.1	26.6	28.2
ADJUSTED ENDING INVENTORY[7]	76.8	91.3	98.0	98.1	91.5	78.0	72.5	67.5	73.4	73.2	71.0	72.0
RELATIVE INVENTORY (yrs)[8]	2.7	4.2	3.7	3.3	2.8	2.3	1.8	1.5	1.5	1.5	1.5	1.5

[1] Nuexco Report 144, Table 1.
[2] Needed to make Ending Inventory (year N) equal 1.5 times Consumption (year N + 1).
[3] George F. Combs, Jr.: "The US Uranium Market—1978-1979" USDOE; Grand Junction, Colorado; October, 1979.
[4] This Report, Table 2.
[5] Nominal Ending Inventory is the unadjusted sum of Beginning Inventory and the annual supply surplus (deficit).
[6] Unfilled US demand is defined as that additional amount of uranium, if any, which US buyers would have to purchase over and above US firm production in order to maintain a minimum relative inventory of 1.5 years forward consumption.
[7] Adjusted Ending Inventory is the sum of Nominal Ending Inventory and Unfilled US Demand.
[8] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Table 4
NATURAL URANIUM SUPPLY-DEMAND BALANCE: WOCA OUTSIDE US
(Assumes US Maintains Minimum Inventory of 18 Months Forward Consumption by Importing)
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[1]												
Operating Production Centers	61.5	69.1	76.5	78.3	80.1	82.1	82.1	83.0	82.9	82.8	82.8	82.8
Facilities Under Construction	-0-	0.3	4.4	6.4	10.2	14.7	16.8	17.8	17.8	17.8	17.8	17.8
Total	61.5	69.4	80.9	84.7	90.3	96.8	98.9	100.8	100.7	100.6	100.6	100.6
less												
CONSUMPTION[2]												
Reactors Now Operational	19.7	21.4	21.4	21.4	21.4	21.5	21.5	21.5	21.5	21.5	21.5	21.5
Now Under Construction	24.2	18.2	27.8	33.1	33.2	31.0	33.2	33.2	32.3	32.3	32.3	32.3
Now On Order	-0-	-0-	-0-	0.9	4.1	7.5	15.2	9.5	14.9	11.4	12.4	13.0
Total	43.9	39.6	49.2	55.4	58.7	60.0	69.9	64.2	68.7	65.2	66.2	66.8
plus												
NET IMPORTS (EXPORTS)[3]	1.8	1.9	(0.3)	(1.5)	(1.2)	(1.7)	(0.1)	(0.6)	(0.6)	(0.6)	(1.0)	(1.1)
less												
ADDITIONAL EXPORTS[4]	-0-	-0-	-0-	-0-	-0-	-0-	15.9	22.6	31.2	29.1	26.6	28.2
equals												
SUPPLY SURPLUS	19.4	31.7	31.4	27.8	30.4	35.1	13.0	13.4	0.2	5.7	6.8	4.5
plus												
BEGINNING INVENTORY	93.6[5]	113.0	144.7	176.1	203.9	234.3	269.4	282.4	295.8	296.0	301.7	308.5
equals												
ENDING INVENTORY	113.0	144.7	176.1	203.9	234.3	269.4	282.4	295.8	296.0	301.7	308.5	313.0
RELATIVE INVENTORY (yrs)[6]	2.1	2.9	2.9	3.2	3.5	3.9	3.9	4.4	4.3	4.5	4.6	4.6

[1] Nuexco Report 141, pg. 1.2.

[2] Nuexco Report 144, Table 1.

[3] Nuexco Report 142, Table 3. Non-US exports equal US imports and vice versa.

[4] Additional Exports to the US needed by the US to maintain a minimum inventory of 18 months forward consumption. Ref. this Report, Table 3, Unfilled Demand.

[5] Nuexco estimate.

[6] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Forecast of US Uranium Production

Nuexco presented estimates of US and world production of U_3O_8 in Report 141. In recognition of the market conditions prevailing at that time, those estimates were based only on facilities which were operating or under construction as of April 30, 1980. The following is excerpted from Report 141:

> *. . . In the US, some existing facilities have begun to reduce production. Some can be expected to suspend production within the next one to three years if present trends continue. The estimate of US uranium production presented in this Report is based upon Nuexco's assessment of the probable output of each producer, which in turn is based upon estimated production cost, ore reserves, and sales commitments.*

Over the past 9 to 12 months, the economics of uranium production have been changing quite rapidly. As spot market prices have dropped, the amount of current US production which has become vulnerable to premature shutdown has increased. In addition, plans for construction of additional facilities have been and continue to be reviewed and reevaluated. At the same time, heightened awareness of rising world inventory levels has increased the likelihood of a prolonged buyers' market.

The forecast of US production presented herein necessarily reflects some subjective opinions about commercial decisions which will be faced over the next few years by US producers. Those decisions will be based on many factors, but the ultimate outcome of production decisions in the US will most probably be determined by the economics of free market competition.

Unlike the US, many other nations have national nuclear power policies. The active promotion of such policies by the governments of those countries allows them to use longer planning horizons than their US counterparts. Additionally, much of the important production outside the US is dedicated to attaining and sustaining national self-sufficiency in the nuclear fuel cycle, or at least in nuclear raw materials. For these reasons, much of what might otherwise be either economically marginal, or excess uranium production outside the US will continue in operation. In addition, much non-US production will be from the high-grade deposits of Australia and Canada, and the by-product production of South Africa. These low cost operations can be expected to continue producing for the foreseeable future. Therefore, the non-US supply figures used in this Section are the same as Nuexco's estimate of U_3O_8 production outside the US as published in Report 141.

Production centers are divided into categories, according to stage of development, as follows:

1. Operating production centers—those which have shipped U_3O_8 in commercial quantities before September 1, 1980.
2. Production centers under construction—those which were being built as of August 31, 1980, and which have an established access to ore reserves. Conventional production centers are included in this category only if mill construction has actually begun.

Each category is further divided, according to source, as follows:

—Conventional milling
—Unconventional recovery methods
  - Solution mining, including *in situ* leaching and hydraulic mining.
  - Phosphoric acid by-product recovery.
  - Heap leaching, including leachings of tailings and copper dumps.

Operating US production centers are listed in Table 5. Centers under construction are listed in Table 6. Table 7 summarizes the estimated U_3O_8 production for each category.

Annual US production is expected to decline from the 1979 level of about 37 million pounds U_3O_8 to about 34 million pounds in 1980 and to about 20 million pounds in 1986. The decrease is due to declining ore grades, depletion of orebodies and production cutbacks due to high costs and low prices.

Table 8 tabulates estimated world uranium production by region; Table 9 contains the same production estimates segmented according to status of the production center. World production for 1979 totalled approximately 99 million pounds U_3O_8, of which non-US production accounted for 62 percent. Table 8 shows the US portion of the world's uranium production declining steadily from its 1979 level of 38 percent.

US Government Statistics

Beginning with the July 1980 issue of "Employment and Earnings," the US Bureau of Labor Statistics (BLS) has adjusted data to the most recent benchmark, that of March 1979. Revised average hourly earnings data for the period January 1977 through March 1980 will be published in a forthcoming supplement to "Employment and Earnings." As soon as possible thereafter, these revised historical data will be reprinted in the Nuexco Report.

The USBLS annually adjusts its industry employment series to more recent benchmarks. Normally, new benchmarks are determined for March of each year. Generally, new benchmarks do not change average hourly earnings data by more than one cent.

There are four basic reasons for the differences between benchmarks and estimates: (1) errors in trends caused by nonrepresentative samples, (2) errors in adjustment for the entry of new firms, (3) improvements in the quality of the benchmark data, and (4) changes in industrial classification of individual establishments.

AUSTRALIA

On August 18 Australian Deputy Prime Minister Anthony announced the initialling of contracts calling for the delivery from the Ranger deposit of about 68 million pounds U_3O_8 over the fifteen year period 1982-1996. Based on previous information, the breakdown of the purchase is tabulated in Table 10.

These transactions provide the basis for the establishment of Energy Resources of Australia (ERA) as a viable uranium venture, including the purchase by Peko-Wallsend and EZ Industries of the government's 50 percent share of Ranger, the financing of the mine

Table 5
OPERATING US PRODUCTION CENTERS

CONVENTIONAL MILLS
- Anaconda Corp.; Grants, NM
- Atlas Minerals Corp.; Moab, UT
- Chevron Resources; Pannamaria, TX
- Conoco-Pioneer Nuclear JV; Falls City, TX
- Cotter Corp; Canon City, CO
- Dawn Mining Co.; Ford, WA
- Energy Fuels; Blanding, UT
- Exxon Minerals Co. USA; Powder River Basin, WY
- Federal-American Partners; Gas Hills, WY
- Kerr-McGee Nuclear; Grants, NM
- Pathfinder Mines Corp.; Gas Hills, WY
- Pathfinder Mines kCorp.; Shirley Basin, WY
- Petrotomics Co.; Shirley Basin, WY
- Rio Algom Corp.; La Sal, UT
- Rocky Mountain Energy; Bear Creek, WY
- Sohio-Reserve; Seboyeta, NM
- Union Carbide Corp.; Uravan, CO
- Union Carbide Corp.; Gas Hills, WY
- United Nuclear Corp.; Church Rock, NM
- United Nuclear-Homestake Partners; Grants, NM
- Western Nuclear, Inc.; Jeffrey City, WY
- Western Nuclear, Inc.; Sherwood, WA

UNCONVENTIONAL SOURCES

Solution Mining:
- Everest Mineral Corp.; Hobson TX
- IEC Corp.; Ray Point, TX
- Mobil Oil Corp.; Holiday El Mesquite, TX
- Mobil Oil Corp.; Ohern, TX
- Uranium Resources Corp.; Bruni, TX
- Uranium Resources-Framco-Conoco JV; Benevedes, TX
- US Steel Corp.; George West, TX
- US Steel-NM Uranium; Clay West, TX
- Wyoming Mineral Corp.; Iragaray, WY
- Wyoming Mineral Corp.; Bruni, TX
- Wyoming Mineral Corp.; Ray Point, TX

Phosphoric Acid By-product:
- Freeport Uranium Recovery Corp.; Uncle Sam LA
- Gardinier, Inc.; Tampa, FL
- IMC Corp.; New Wales, FL
- Wyoming Mineral Corp.; @ Farmland Industries, Pierce, FL

Heap Leaching:
- Anamax Mining Co.; Sahuarita, AZ
- Solution Engineering, Inc.; Falls City, TX
- Union Carbide Corp.; Maybell, CO
- Wyoming Mineral Corp.; Bingham Canyon, UT

Table 6
US PRODUCTION CENTERS UNDER CONSTRUCTION

CONVENTIONAL MILLS
- Bokum Resources; Marquez, NM
- Minerals Exploration; Sweetwater, WY
- Plateau Resources; Shootering Canyon, UT

UNCONVENTIONAL SOURCES

Solution Mining
- Caithness Corp.; Bruni, TX
- Mobil Oil Corp.; Nell, TX
- Mobil Oil Corp.; Piedre Lumbre & Brelum, TX

Phosphoric Acid By-product:
- Earth Sciences; Calgary, Alberta
- Freeport Uranium Recovery Corp. @ Agrico; Faustina, LA
- IMC Corp. @ CF Industries; Plant City, FL
- IMC Corp. @ CF Industries; Bartow, FL

Table 7

US URANIUM PRODUCTION FORECAST

(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
OPERATING												
Conventional Mills	33.4	28.7	23.2	20.0	19.1	17.0	14.4	13.5	12.8	12.7	12.7	12.7
Unconventional Sources	3.6	5.5	6.1	6.0	5.6	5.0	4.6	3.6	3.5	3.5	3.5	3.5
Subtotal	37.0	34.2	29.3	26.0	24.7	22.0	19.0	17.1	16.3	16.2	16.2	16.2
UNDER CONSTRUCTION	-0-	0.3	2.0	2.5	2.7	3.0	3.0	3.0	2.8	2.8	2.8	2.8
TOTAL (rounded to nearest million)	37	35	31	29	27	25	22	20	19	19	19	19

Table 8

ESTIMATED WORLD URANIUM PRODUCTION[1]

(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Australia	1.8	2.3	3.8	4.3	6.9	9.3	9.1	9.1	9.1	9.1	9.1	9.1
Canada	17.5	19.0	20.9	21.6	21.6	23.1	24.6	24.6	24.6	24.6	24.6	24.6
Republic of South Africa	12.5	15.1	18.5	19.4	20.2	20.7	21.1	21.5	21.5	21.5	21.5	21.5
Other Africa	21.8	23.7	26.8	27.8	29.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6
Other Nations[2]	7.9	9.2	11.1	11.6	11.9	11.9	12.4	14.0	14.0	14.0	14.0	14.0
Non-US Total[3] (rounded to nearest million)	62	69	81	85	90	97	99	101	101	101	101	101
US[4]	37	35	31	29	27	25	22	20	19	19	19	19
Total	99	104	112	114	117	122	121	121	120	120	120	120

[1] Outside Communist Area.
[2] Includes Argentina, Brazil, France, Mexico, Spain and others, but does not include Communist areas.
[3] Nuexco Report 141, Table 5.
[4] This Report, Table 7.

Table 9

ESTIMATED WORLD URANIUM PRODUCTION[1]

(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
OPERATING												
US	37.0	34.2	29.3	26.0	24.7	22.0	19.0	17.1	16.3	16.2	16.2	16.2
Non-US	61.5	69.1	76.5	78.3	80.1	82.1	82.1	83.0	82.9	82.8	82.8	82.8
Subtotal	98.5	103.3	105.8	104.3	104.8	104.1	101.1	100.1	99.2	99.0	99.0	99.0
UNDER CONSTRUCTION												
US	-0-	0.3	2.0	2.5	2.7	3.0	3.0	3.0	2.8	2.8	2.8	2.8
Non-US	-0-	0.3	4.4	6.4	10.2	14.7	16.8	17.8	17.8	17.8	17.8	17.8
Subtotal	-0-	0.6	6.4	8.9	12.9	17.7	19.8	20.8	20.6	20.6	20.6	20.6
TOTAL[2]	99	104	112	114	117	122	121	121	120	120	120	120

[1] Outside Communist Areas.
[2] Rounded to nearest million.

Table 10

NON-AUSTRALIAN PARTICIPATION IN ENERGY RESOURCES OF AUSTRALIA (ERA)

	Percentage Ownership of ERA	Approximate Annual Quantity (millions of pounds U_3O_8)	Approximate Total Quantity, 1982-1996 (millions of pounds U_3O_8)
UTILITIES			
RWE	6.51	1.30	17.7
Kansai	5.21	1.04	14.2
Kyushu	2.60	0.52	7.1
Shikoku	1.56	0.31	4.3
OTHERS			
Urangesellschaft	4.17	0.84	11.3
Saarberg-Interplan	3.91	0.78	10.6
C. Itoh	1.04	0.21	2.8
TOTALS	25	5.0	68.0

and mill complex, the marketing of most of the output, and the public float of part of ERA's equity to the Australian public. The breakdown of ERA ownership will be:

Peko Wallsend	30.5%
EZ Industries	30.5%
German interests	14.6%
Japanese interests	10.4%
Public ownership	14%
	100%

Of particular interest is the fact that almost two million pounds annually has been committed to non-end users which, so far as is presently known, have yet to include firm agreements for resale of this tonnage. The policy of the Australian government in this regard has shifted, for whereas such resale was formerly a precondition to equity participation, it has been learned that this position has been eased to require only that such approved resale agreements be in effect prior to export of the material.

The government indicated in its announcement that the sales were in accordance with Australian guidelines, i.e. firm take and pay arrangements with floor and market price provisions. If so, it must be assumed that the purchasers which are not end-users elected to take the market risk in a time of considerable price uncertainty. Such risk-taking would appear to be most unlikely, which raises the question of what, if any, mechanism exists in the contracts to provide the buyers with relief in the event that the floor price exceeds market.

CANADA

There has been considerable speculation in the industry regarding policy considerations connected with the Rio Algom (formerly Preston) and Denison contracts with Ontario Hydro. These contracts received final approval in 1978 and, at the time they were signed, the industry was reminded that the Canadian Government had a policy that uranium exports from Canada would not normally be approved at prices or terms and conditions more favorable than those available to Canadian utilities.

The question that is now being debated is, given the situation where these large (198 million pounds), long term (final deliveries in the year 2020) contracts are in effect at prices that are by now almost certainly higher than current spot market prices, what will be the reaction of the Canadian Government to the granting of new export permits. The answer appears to be that the Canadian government policy is being interpreted in a contemporaneous manner. That is, at any given point in time, the government's policy is that there should not be a substantial mismatch between terms and conditions being offered internationally versus those being offered domestically. Thus, the older sales to Ontario Hydro do not necessarily establish a pricing floor for new exports.

Separately, the Rio Algom and Denison agreements with Ontario Hydro are now "under review" at the provincial level and will probably be the subject of provincial hearings near the end of the year.

The Cluff Lake production center in northern Saskatchewan is nearing completion and should begin production in early 1981. The deposit is owned 80 percent by Amok, Ltd. and 20 percent by Saskatchewan Mining Development Corporation. Proven ore reserves total about 50 million pounds U_3O_8. The initial annual production rate is expected to be 2.6 million pounds U_3O_8.

Figure 1 is an aerial view of the Cluff Lake site. Figure 2 is a close-up photograph showing the covered ore stockpiles in the foreground, with the metallurgical plant in the background.

EUROPE

The amount of electricity produced by nuclear power in the European Economic Community increased in the first quarter of 1980 by about 21 percent, compared to the first quarter of 1979. This was due in large part to new plants coming on line in France, where nuclear generation increased more than 50 percent between first quarter, 1979 and first quarter, 1980.

The French nuclear program continues to progress. During July, 1980, the French reactors Gravelines unit 1 and Tricastin unit 1 both reached full power operation for the first time. Also during July, Tricastin unit 2 achieved its first criticality, and in early August Gravelines unit 2 reached initial criticality.

FAR EAST

The equity participation of **Japan** in Australia's Ranger project had been announced (see Australia section of this Report). Prior to this announcement, approximate distribution of sources of uranium under contract to Japanese utilities was as follows:

Canada	40%
South Africa	40%
Australia	10%
Other (US, Niger, France)	10%

This purchase of over 28 million additional pounds from Australia will alter the geographical balance, reducing current dependence on Canada and South Africa and increasing security of overall supply through diversity. The Ranger purchase will change the balance as follows:

Canada	36%
South Africa	36%
Australia	19%
Other	9%

UNITED STATES

The US Nuclear Regulatory Commission voted to authorize Virginia Electric and Power Company to operate its North Anna unit 2 reactor at full power. This marks the first such license issued since the Three Mile Island accident.

The average price of uranium paid by US utilities for 1979 delivery, as compiled by USDOE, was $23.85. This was up from $21.60 in 1978, and $19.75 in 1977.

On July 31, 1980, USDOE announced an increase in the price of uranium enrichment services. Separative work performed under Fixed-Commitment contracts will be increased from $98.95 per SWU to $110 per SWU. The effective dates of the change will be September 30, 1980 (60 days notice), in the case of Long-Term Fixed-Commitment contracts, and November 29, 1980 (120 days notice) in the case of Adjustable Fixed-Commitment contracts.

The charge under Requirements-type contracts will also be increased from $110.75 or the formula ceiling price (presently estimated at $105.54 per SWU), whichever is lower, to $119.00 or the formula ceiling price, whichever is lower. The effective date of this change will be January 28, 1981 (180 days notice).

The nuclear platform planks of both the Republican and Democratic Parties contain endorsements of the continuation of nuclear power in the US, although in different degrees. The Republicans enthusiastically call for "accelerated use of nuclear energy through technologies that have been proven efficient and safe." However, the Democrats, facing a strong antinuclear lobby seeking a full nuclear moratorium, promise to "retire nuclear plants in an orderly manner" as alternate forms of energy become available.

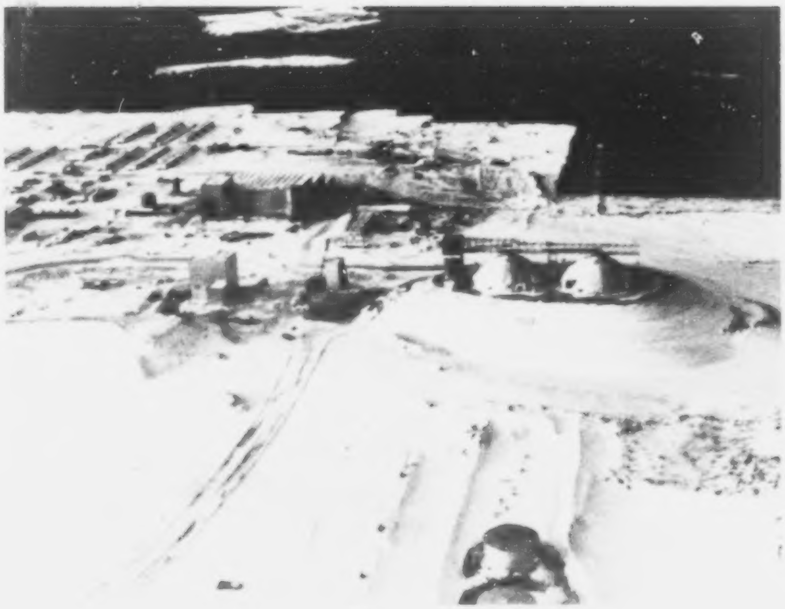

Figure 1
AERIAL VIEW OF THE CLUFF LAKE SITE IN NORTHERN SASKATCHEWAN

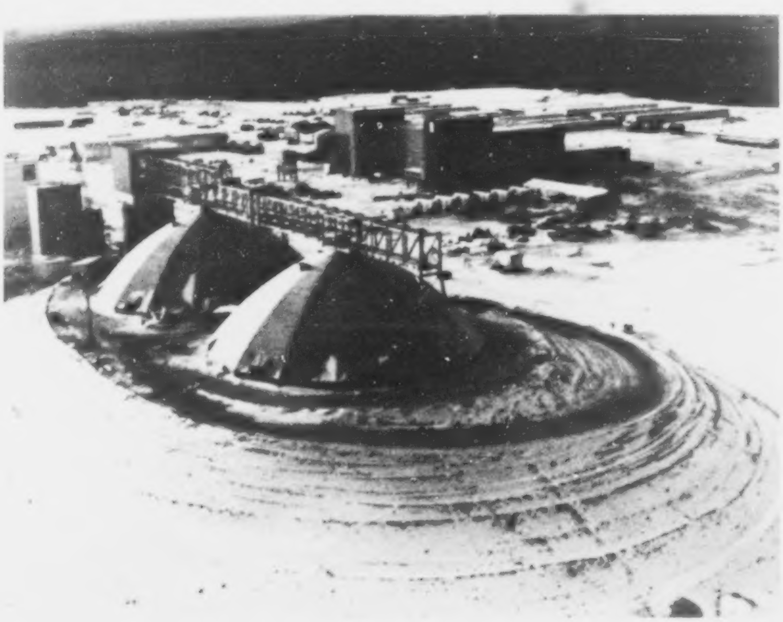

Figure 2
CLOSE-UP OF THE CLUFF LAKE MILL. THE ORE STOCKPILES ARE IN THE FOREGROUND. THE METALLURGICAL PLANT IS IN THE BACKGROUND.

URANIUM MARKET

Kerr-McGee Nuclear Corporation has announced the closing of two uranium mines at Ambrosia Lake, New Mexico. Also, operations at Anaconda's Jackpile uranium mine in New Mexico will be phased out by the end of the year. Rising costs and projected future uranium prices were cited as reasons for the closings.

TRANSACTIONS

Ten transactions were concluded this month in addition to the series of transactions associated with the establishment Energy Resources of Australia (see Australia section). Nine of the ten transactions were for spot and near-term delivery. One large sale was between a Canadian producer and a US utility for between 600,000 and one million pounds of U_3O_8. Another US utility purchased two small quantities of material from two US producers. One of the deals was for less than 50,000 pounds, the other for under 100,000 pounds. A European firm sold less than 50,000 pounds to a Japanese trading company with delivery to occur in 1981. A US producer sold less than 50,000 pounds to a US utility, with deliveries extending into 1981. A US producer sold a small quantity to a Far East government entity.

There were three transactions this month involving US utilities as sellers. In one transaction, a US nuclear contractor purchased between 100,000 and 300,000 pounds U_3O_8. In the second, a US producer purchased between 50,000 and 100,000 pounds. In the third, a European utility purchased between 100,000 and 300,000 pounds U_3O_8.

Finally, Queensland Mines, Ltd. of Australia announced the sale of 1.8 million pounds U_3O_8 to TVO of Finland. Delivery is scheduled for 1981 through 1989.

PRICING

The price decline in the first part of 1980 was caused, at least partially, by utilities' selling inventory due to the high interest rates. As prices dropped, and interest rates lowered, pressure by utilities to sell inventory eased somewhat. Thus the market has remained in a metastable condition over the past few months. Now, however, several buyers have emerged attempting to secure favorable prices on intermediate and long term uranium supply contracts. In response to these inquiries, uranium producers have begun active price competition in order to sell material for all delivery schedules, spot through long-term.

In competing for this business, most US producers are trying to cover higher production costs by seeking escalated floor prices or other contract provisions aimed at avoiding selling at a loss. Some non-US producers, however, are offering terms which reflect their much lower production costs. Because of this, non-US producers are beginning to capture a larger share of the US market, at price levels where few, if any, US producers can effectively compete. This applies to the spot and near-term markets as well as the longer term.

Continued competition in the US market from non-US producers may have a significant effect on US production. US producers face difficult decisions at this time on how to respond to active inquiries from utilities, especially when these buyers may not re-enter the uranium market for another decade. It now appears, however, that non-US producers are taking advantage of the current opportunities to become market leaders in the US.

The **Exchange Value** decrease to $30.00 per pound U_3O_8 this month, down from $31.50 last month. The decline is due mainly to active competition among non-US producers, although a few inventory holders are making renewed efforts to sell.

The **Transaction Value** decreased to $31.60 per pound U_3O_8. Several transactions closed this month, thus making it possible to drop from the sample the large number of transactions which were reported in Report 139, when spot prices were higher.

CONVERSION

As indicated in the *Market Opportunities* section of this Report, the amount of conversion services currently being offered for sale in the secondary market is very large. At the same time, there is essentially no demand for spot conversion. There remains substantial depth in the market to sell conversion at about $1.50 per pound U as UF_6. However, the extreme excess of supply in this market will likely put downward pressure on offered prices in the near future.

TOPICAL ESSAY

HISTORICAL PERSPECTIVE ON US URANIUM PRODUCTION

The supply and demand balance discussed in the *General* section of this Report indicates that the world uranium market is in an oversupply condition, which will probably continue for some time. This situation would indicate the continuation of a relatively strong buyers' market. Because the US uranium industry is a high cost industry relative to the other major uranium producing countries, it is expected that US production will tend to decrease. Competition from non-US production, as well as the effect of the large and growing US utility inventory position, is mainly responsible for the projection by Nuexco of declining US production levels over the next few years.

US uranium production in 1980 will probably be nearly double US consumption. (See Table 2, above.) In fact, production of uranium in the US has been greater than US power reactor consumption in every year of the existence of the commercial nuclear program. However the present imbalance is being exacerbated by the many long-term supply contracts currently in existence. Deliveries under these contracts are pumping much unneeded uranium into users' inventories.

The major driving forces leading to this result developed years ago. Anticipated uranium shortages combined with the implementation of the long-term fixed-commitment enrichment contract prompted users to sign long-term uranium contracts. More recently, reactor schedule slippages and cancellations, combined with relaxation of enrichment contracts by USDOE have resulted in many utilities' taking delivery of unneeded uranium. The buildup of excess inventory will probably lead to overcorrection in the long run, in the form of weak demand and resultant declining supply. While existing supply contracts can be expected to underpin US production over the next few years, their effect will be attenuated somewhat as some producers choose to purchase material on the spot market rather than produce it themselves.

A revised Nuexco forecast of US uranium production is tabulated in Table 7 of this Report. The forecast is based on Nuexco's assessment of the individual situation of each producer or potential producer in response to the current and expected market climate. The conclusion is that US uranium production probably reached its maximum in the 1978–79 period, and will likely fall over the next few years.

It is interesting to compare today's market situation with similar situations in the history of the US uranium industry. Figures 3 and 4 were prepared to provide a basis for determining if past experience would help assess the potential extent and rate of change in US production in response to today's market.

Figure 3 contains a plot of total US uranium production for the years 1950 through 1979. Also plotted in Figure 3 are three indicators of uranium price over the years: the annual average price paid by the USAEC for US uranium during its procurement program, the annual average Nuexco Exchange Value, and the annual average price paid by US utilities, as compiled by the USDOE. All of the prices plotted in Figure 3 are in First Quarter 1980 dollars, adjusted for inflation by the GNP Implicit Price Deflator published by the US Department of Commerce.

Figure 3 was prepared only to serve as an intermediate step. The data plotted in Figure 3 omit a very important factor, namely cost of production. In an effort to take this factor into account, Figure 4 was developed. Figure 4 contains the same plot of US production as Figure 3. The same three price indicators plotted in Figure 3 are plotted in Figure 4, after having been adjusted for changes in grade of ore over the years. That is, all price data in Figure 4 were adjusted to the 1979 US average grade of ore by multiplying by the ratio of US average ore grade in the year in question to US average ore grade in 1979. Grade of ore is generally the most sensitive variable in cost of production in the mining industry. Average US ore grade was about 0.30 percent U_3O_8 in the early 1950's, and has fallen steadily to about 0.11 percent in 1979. Adjusting the price indicators both to today's dollars and to today's grade of ore should yield a rough figure of merit on *relative* profitability in the uranium industry over the years, since it would take into account changes in dollar prices, changes in production cost, and inflation. For convenience, the data used in developing Figures 3 and 4 are tabulated in Table 11.

Some interesting conclusions can be deduced from Figure 4:

1. US uranium producers' profitability fell steadily from the early 1950's through the early 1970's. The fall is exaggerated somewhat by the fact that early uranium production centers were depreciated

TOPICAL ESSAY

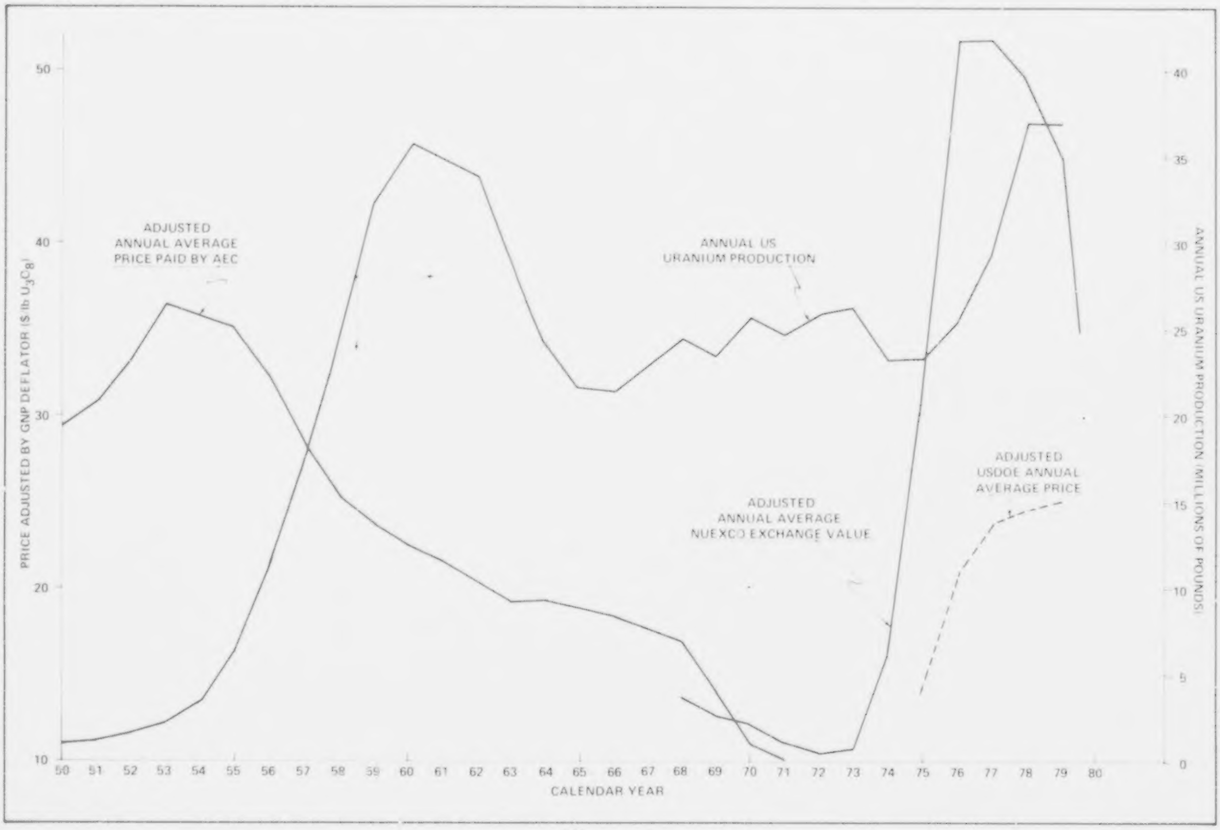

Figure 3
RELATIONSHIP BETWEEN US PRODUCTION AND THE CONSTANT DOLLAR PRICE OF URANIUM

quickly. Thus relative profitability was probably somewhat lower in the early years.

2. Steadily decreasing profitability apparently led to a peaking and falloff of production in the early 1960's.
3. Relative profitability did not change much on an *average* basis from the mid 1960's to the present time. The adjusted average USAEC prices in the mid to late 1960's and the adjusted average USDOE prices for recent years are roughly comparable.
4. Increasing spot prices in the mid 1970's brought about an expected (and, in some cases, a realized) increase in profitability which resulted in the expansion of US production to an annual level of about 37 million pounds U_3O_8.
5. At present there is a large gap between production level and relative profitability.

In fact, today's relative profitability, measured either by the current Exchange Value or the most recent USDOE average price, is very low. On the other hand, the US production was at its highest level as of 1979. This implies that US production will very likely fall off in the future if current price trends and production cost trends continue. The rate of decline will probably be relatively steep because, in addition to other economic pressures, many US producers are expected to purchase part of their existing delivery commitments, rather than produce the material themselves.

The logical conclusion is that, unless the *real* price of uranium increases substantially, US production will drop, and the US will soon need to import substantial quantities of uranium. It is important to recognize, however, that this need to import will be the result of economics and not the result of lack of uranium resources. Thus the situation in the uranium industry is not immediately comparable to that in the petroleum industry. However, discovery of low-cost deposits in the US of a type comparable to those of Australia and Canada would alter the situation considerably.

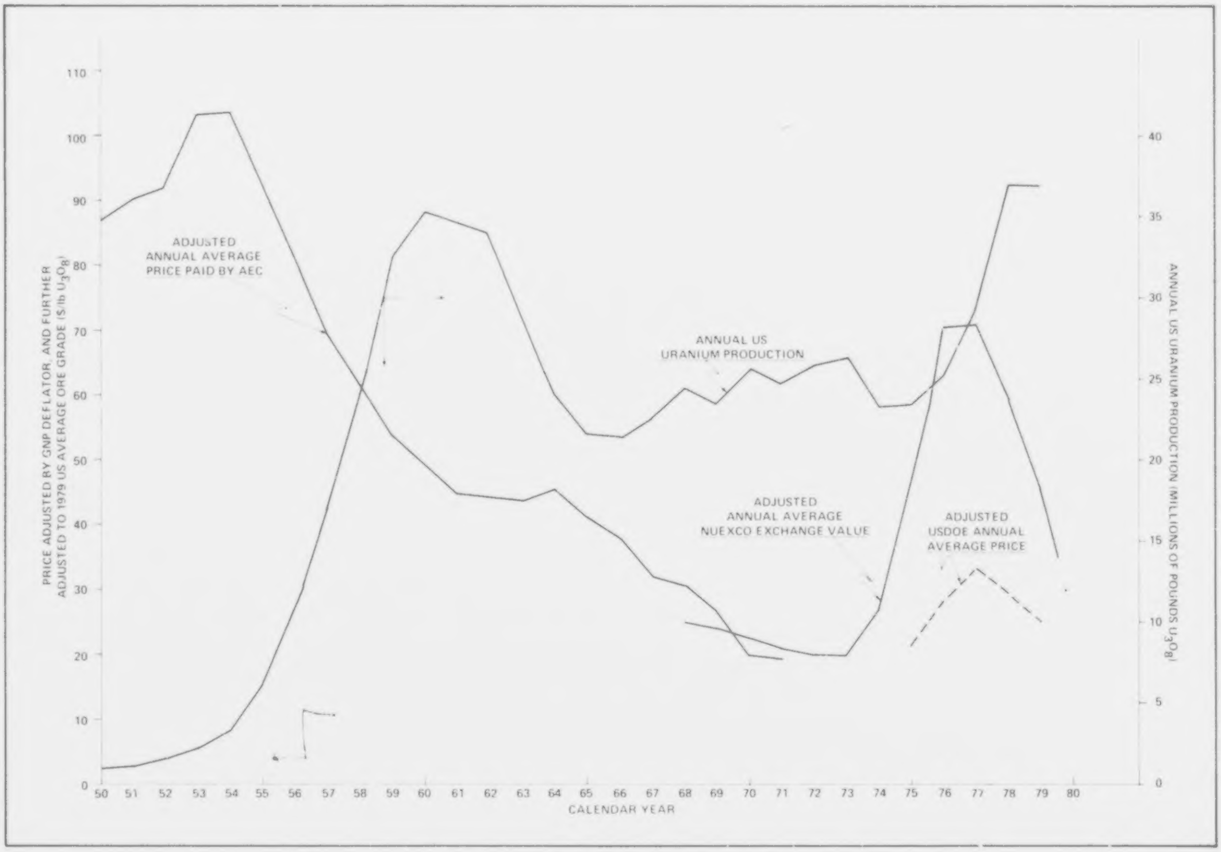

Figure 4
RELATIONSHIP BETWEEN US PRODUCTION AND THE RELATIVE PROFITABILITY OF THE US URANIUM INDUSTRY

Table 11
DATA USED TO DEVELOP FIGURES 3 AND 4 OF THIS REPORT

Year	USAEC Annual Average Price Paid[1] [2]	NUEXCO Average Annual Exchange Value	USDOE Annual Average Price Paid[3] by US Utilities	GNP Implicit Price Deflator[4] (1972 = 100)	Annual Average US Grade of Ore[1] (percent U_3O_8)
1950	9.11			53.64	0.32
1951	10.10			57.27	0.32
1953	12.35			58.88	0.31
1954	12.27			59.69	0.32
1955	12.25			60.98	0.29
1956	11.51			62.90	0.28
1957	10.49			65.02	0.27
1958	9.45			66.06	0.27
1959	9.12			67.52	0.25
1960	8.75			68.67	0.24
1961	8.50			69.28	0.23
1952	8.15			69.28	0.23
1962	8.15			70.55	0.24
1953	7.82			71.59	0.25
1964	8.00			72.71	0.26
1966	8.00			76.76	0.23
1967	8.00			79.02	0.20
1968	8.00	6.40		82.57	0.20
1969	6.99	6.20		86.72	0.21
1970	5.74	6.25		91.36	0.20
1971	5.54	6.06		96.02	0.21
1972		5.95		100.00	0.21
1973		6.40		105.80	0.21
1974		11.00		116.02	0.18
1975		23.70	10.50	127.18	0.16
1976		39.70	16.10	133.88	0.15
1977		42.20	19.75	141.61	0.15
1978		43.25	21.60	152.05	0.13
1979		42.60	23.85	165.46	0.11
1980		33.75[5]		174.51[6]	

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[1] Statistical Data of the Uranium Industry; January 1, 1980; GJO-100(80).

[2] Data is for fiscal year indicated.

[3] Survey of United States Uranium Marketing Activity; August 1979; DOE RA-0038.

[4] US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis "Survey of Current Business."

[5] First eight months.

[6] First quarter.

RAW MATERIALS

URANIUM IN ARGENTINA

Introduction

In the late 1940's the government of Argentina began to consider the country's future energy requireents and how it could achieve energy self-sufficiency by the year 1985. One basic conclusion at the time was that the country's energy base would have to be broadened greatly from a high dependence on oil and gas to a greater percentage of coal and hydro, and the new energy source, nuclear power. With that decision, the government began to evaluate the potential for uranium resources in Argentina.

A preliminary evaluation program was sanctioned for the area of crystalline rocks in the Cordoba and San Luis Mountains as early as 1946, resulting in the discovery of uranium-bearing quartz veins. Encouraged by this, the government formed the National Atomic Energy Directorate, to coordinate the total evaluation effort. Metamorphic rocks in the mountainous areas were included in the evaluation program.

The apparent success of the early resource evaluation program was a factor in the government's decision to begin a nuclear power generating program with an initial target capability of 3300 Mwe. The plan called for six generating units—the first of which began operating in 1974. The second unit is scheduled to be on line in 1982.

The final government decision to proceed with the nuclear program was based in part upon a predetermined conclusion that all uranium requirements could be supplied from indigenous sources. All evaluation activity was consolidated under one government agency, the Comision National de la Energia Atomica (CNEA), in 1956 to expedite the program. The success of the program is indicated by the fact that uranium resources recoverable at US $50 or less per pound U_3O_8, are estimated at 28,000 tonnes U_3O_8.

The CNEA has a continuing exploration program to search for additional uranium resources. For the first time, foreign groups are now allowed to explore for uranium if they can demonstrate technical and financial capabilities to the CNEA. A participating group can earn a 50 percent interest in a uranium deposit, of which 25 percent of the mined product can be sold; the remaining 25 percent must be sold to the CNEA.

Geology

Uranium mineralization is known to occur in a variety of different rock-types throughout Argentina, primarily in the provinces of Jujuy, Salta, La Rioja, Cordoba, Catamaca, Mendoza, Neuquen and Chubut. Geologically, the main areas of interest are the Jurassic and Cretaceous sediments in Mendoza Province, and the Cretaceous and Tertiary sediments in Jujuy and Salta Provinces. The sediments are considered to offer the greatest potential for large uranium resources, even though numerous important occurrences have been discovered in other rock types. Figure 5 shows the location of uranium deposits, mines, and milling facilities throughout Argentina.

Mineralization has been found in Precambrian crystalline rocks and metamorphosed slates in the mountains of Cordoba. The ore minerals show dispersion throughout the coarse-crystalline segment of the intrusive rocks, and often in localized high-grade concentrations along formation contact zones. Small tonnages of high-grade ore have also been found associated with columbite in pegmatite dikes which occur in the same crystalline rocks.

In the Comachingones district of southern Cordoba province, uranium and fluorite occur together in porphyritic granite and metamorphic contact rocks. Uranium and thorium mineralization are found as fracture fillings in Precambrian granites and metamorphics in Jujuy and Salta provinces, primarily in the Jujena district and the area of Sierra de Rangel. In the San Isidro district of Mendoza, uranium mineralization occurs in a highly brecciated zone within Triassic sedminets, and lightly scattered throughout Carboniferous and Permian granites. Uranium-bearing quartz veins are rather common to most of the described rock types.

All the above occurrences are considered to be of hydrothermal origin—that is, mineralization was precipitated from ascending hot aqueous solutions. The origin of the mineral-bearing solutions was probably associated with deep-seated igneous activity, however precipitation of the mineral probably occurred during a later geologic period.

Generally, the hydrothermal uranium occurrences of Argentina contain only a limited amount of recoverable uranium. Estimated ore reserves are low and past production has been insignificant. However, evaluation of geologically favorable intrusive and metamorphic rocks continues. The geology is favorable for the occurrence of either a large disseminated occurrence in granitic rocks, similar to the Rossing

RAW MATERIALS

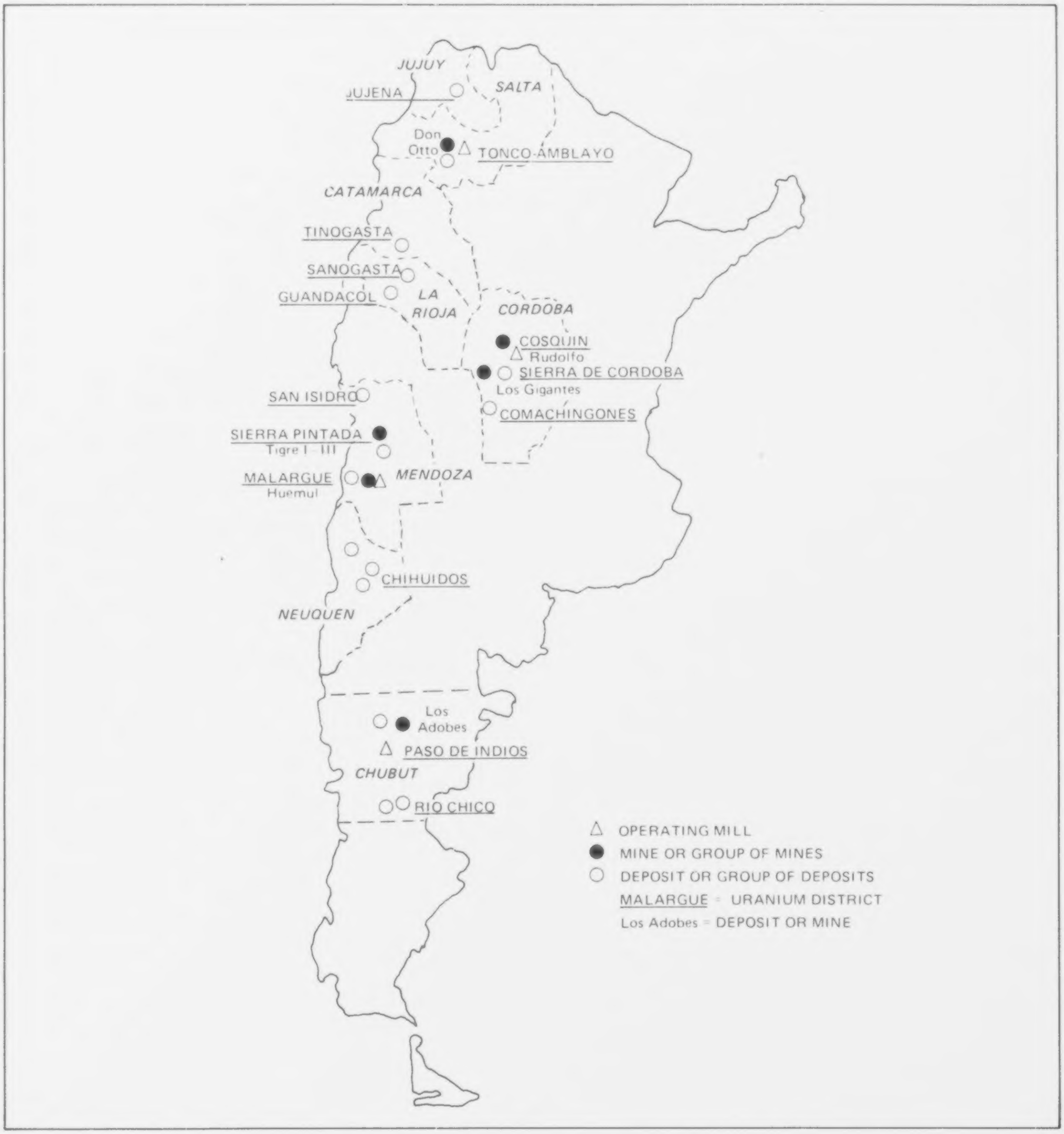

JUJUY
SALTA
JUJENA
Don Otto
TONCO-AMBLAYO
CATAMARCA
TINOGASTA
SANOGASTA
GUANDACOL
LA RIOJA
CORDOBA
COSQUIN
Rudolfo
SIERRA DE CORDOBA
Los Gigantes
COMACHINGONES
SAN ISIDRO
SIERRA PINTADA
Tigre I - III
MALARGUE
Huemul
MENDOZA
CHIHUIDOS
NEUQUEN
Los Adobes
PASO DE INDIOS
CHUBUT
RIO CHICO
△ OPERATING MILL
● MINE OR GROUP OF MINES
○ DEPOSIT OR GROUP OF DEPOSITS
MALARGUE = URANIUM DISTRICT
Los Adobes = DEPOSIT OR MINE

Figure 5
MAP OF ARGENTINA SHOWING EACH PROVINCE WITH URANIUM DEPOSITS, MINES & MILLS

deposit in Namibia, or a large, high-grade vein deposit in metamorphic rocks, such as the Schwartzwalder deposit in the Colorado Front Range of the US.

Mineral Deposits

The greatest number of known uranium occurrences in Argentina are found in sandstone formations. The most important deposits are in Permian and Cretaceous formations. Mineralization and small ore deposits are known to occur in sediments of Upper Paleozoic, Mesozoic and Tertiary formations.

The *Sierra Pintada* district of Mendoza Province is probably the largest in the country. There are at least 12 deposits in the Sierra Pintada district that are presently of economic interest. The main zone of mineralization usually occurs in the Atigrades Sandstone Member of the Los Reyunos Formation. The sand unit shows cross-bedding with conglomeratic stringers common to the lower bottomset beds; mudstone lenses are present, but are less common than the conglomerates.

The sandstone member is 70 to 80 meters thick with a thin marker bed of tuffite near the middle. Uranium mineralization occurs primarily in the sand unit above the tuffite, but important concentrations occur below it as well. The ore zones vary in thickness from 2 to 12 meters; the ore grade ranges from 0.05 to 0.15 percent U_3O_8. The main ore minerals are uraninite, brannerite and coffinite—all primary minerals. The secondary mineral uranophane has been identified in altered rock near the top of the deposit. It occurs as then coatings along joints and fault planes in the sandstone.

Most known deposits in the Sierra Pintada district have been displaced by faulting which followed mineral deposition. For example, the largest deposit, the Tigre I, is divided into three separate ore blocks by two parallel, east-west faults. The south ore block has been displaced downward 80 to 120 meters lower than the north block. A number of smaller north-south faults have further broken up each ore block. The pitch of the ore zones varies from about 12 degrees southward on the north block to as much as 30 degrees southward on the south block.

The ore genesis proposed for the district is based upon a process of leaching uranium from younger acid volcanics which once covered the entire Sierra Pintada region. Precipitation of the uranium from the ground water and into the Atigradas Sandstone followed, forming typical peneconcordant-type deposits similar in occurrence to the deposits in the Grants uranium belt of New Mexico.

The ore reserves at the Tigre I deposit were upgraded in 1978. According to the last estimate of recoverable reserves, the deposit contains about 15,200 tonnes U_3O_8. This represents the largest known uranium deposit in Argentina. Other important deposits in the Sierra Pintada district include the Tigre II & III and the Media Luna I, II and III, located one to two kilometers south of Tigre I. The geology of the latter deposits is similar to Tigre I.

The *Malargue* district is probably the second most important uranium district in Argentina. It is situated about 40 kilometers south of the village of Malargue in Mendoza Province. Uranium deposits of the district occur in the Diamantian Formation of Upper Cretacous Age. The formation consists of a thick arkosic sandstone and conglomerate series with interbedded clay and sandstone stringers. Andesite dikes of Tertiary Age have intruded the Diamantian Formation causing intense fracturing at the contact. Also fragments of carbonaceous material occur throughout the formation, showing greater concentration at, or near, gradational contacts with the clay and sandstone. Formation thickness varies from about 800 to 1100 meters in a south to north direction.

Uranium mineralization in the Malargue district also occurs in conjunction with copper. Uranium was first identified in the district in copper ores from the Cerro Mirano mine in 1952. The CNEA began prospecting the area, and within a short time, over twenty uranium occurrences had been found in the Diamantian Formation. Both uranium and copper mineralization are concentrated in bedded deposits at several different stratigraphic horizons, usually within the lower third of the formation.

The upper portions of the ore deposits are usually oxidized. The uranium and copper mineralization in the upper portions consists of secondary minerals. The uranium minerals are carnotite, tyuyamunite and autunite. Carnotite is the predominant mineral and it occurs as high-grade stringers in fractures and as a coating around the conglomerate matrix. Tyuyamunite and autunite are much less prominant and are not important as ore minerals. The unoxidized lower portions of the ore deposits contain primary minerals of uranium and copper. Uraninite is the principal uranium mineral. The mineral thucholite, a complex mineral containing uraninite, hydrocarbons and thorium, is common in some deposits, but it is not important as an ore mineral.

The important deposits within the Malargue district include Huemul, Agua Botada, Pamap Amarilla and Cerro Mirano. There is little information on reserves or the status mining in the district. A processing mill is operating in the area at an annual capacity of about 50 tonnes U_3O_8.

The *Chihuidos de Medio* district in Neuquen Province is now being actively explored. Uranium has been found in smali deposits in the Diamantian Formation. The geologic setting is comparable to the Malargue district. Uranium discoveries there have been less important than in other areas.

Numerous uranium occurrences have been discovered in the *Tonco-Amblayo* district in Salta Province and the *Jujena* district in Jujuy Province. The host rock is silt, mudstone, sandstone and sandy-limestone of the Salta Formation of Upper Cretaceous Age. The uranium mineralization is considered to be epigenetic, being leached from Precambrian intrusives and metamorphic rocks, and precipitated in the Salta Formation. In addition, uranium mineralization is known to occur in sedients of Upper Pliocene (Tertiary) age.

Uranium occurrences in sandstone have been found in the provinces of Catamarca, Cordoba, La Rioja and Chubut. Host rocks vary in age from Triassic to Tertiary. Generally, the deposits are small and require additional evaluation. However, the Los Gigantes and Rudolfo deposits in the *Sierra de Cordoba* and *Cosquin* districts of Cordoba are being mined, or are under development, as is the Los Adobes deposit in the *Paso de Indios* district of Chubut Province.

Production Centers

Four processing plants, located in four different districts, are now in operation. (See Figure 5.) The Don Otto Mine and mill are located in the *Tonco-Amblayo* district of Salta Province. Mine production is about 60,000 tonnes of ore annually, all of which is processed at the nearby mill. Annual mill production has been about 30 tonnes U_3O_8. Rated mill capacity is about 50 tonnes U_3O_8 per year.

The mill in the *Cosquin* district of Cordoba Province produces about 25 tonnes U_3O_8 per year from ore supplied form the nearby Rudolfo mine.

Several deposits are being mined, or are now under development to supply the mill in the *Malargue* district. In addition, ore is mined at the Tigre I & III deposits in the *Sierra Pintada* district and trucked about 180 kilometers to the Malargue mill. Annual production of the Malargue mill is about 50 tonnes U_3O_8. It is probable that the mill will be expanded to an annual capacity of 365 tonnes U_3O_8 by 1983. Construction of a mill in the *Sierra Pintada* district is also a consideration, primarily to eliminate the long haul to Malargue.

In the *Paso de Indios* district of Chubut Province, mined ore from the Los Adobes deposit is being processed at the Pichinan milling complex. Annual production is about 35 tonnes U_3O_8. The mill might be expanded to provide milling capacity for the accelerated mining program now being considered.

Total annual production in Argentina is presently about 140 tonnes U_3O_8. Rated capacity is estimated at 180 tonnes U_3O_8. Most U_3O_8 production will probably be used in the Argentine nuclear power program, although a small amount was recently committed for export. U_3O_8 production has been steady since the late 1960's and Argentina currently enjoys a surplus of domestic U_3O_8.

STATISTICAL DATA

EXCHANGE VALUE—$30.00/lb U_3O_8
Determined as of August 31, 1980

Definition

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of August 31, 1980

$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
31.60	2.4	17	5

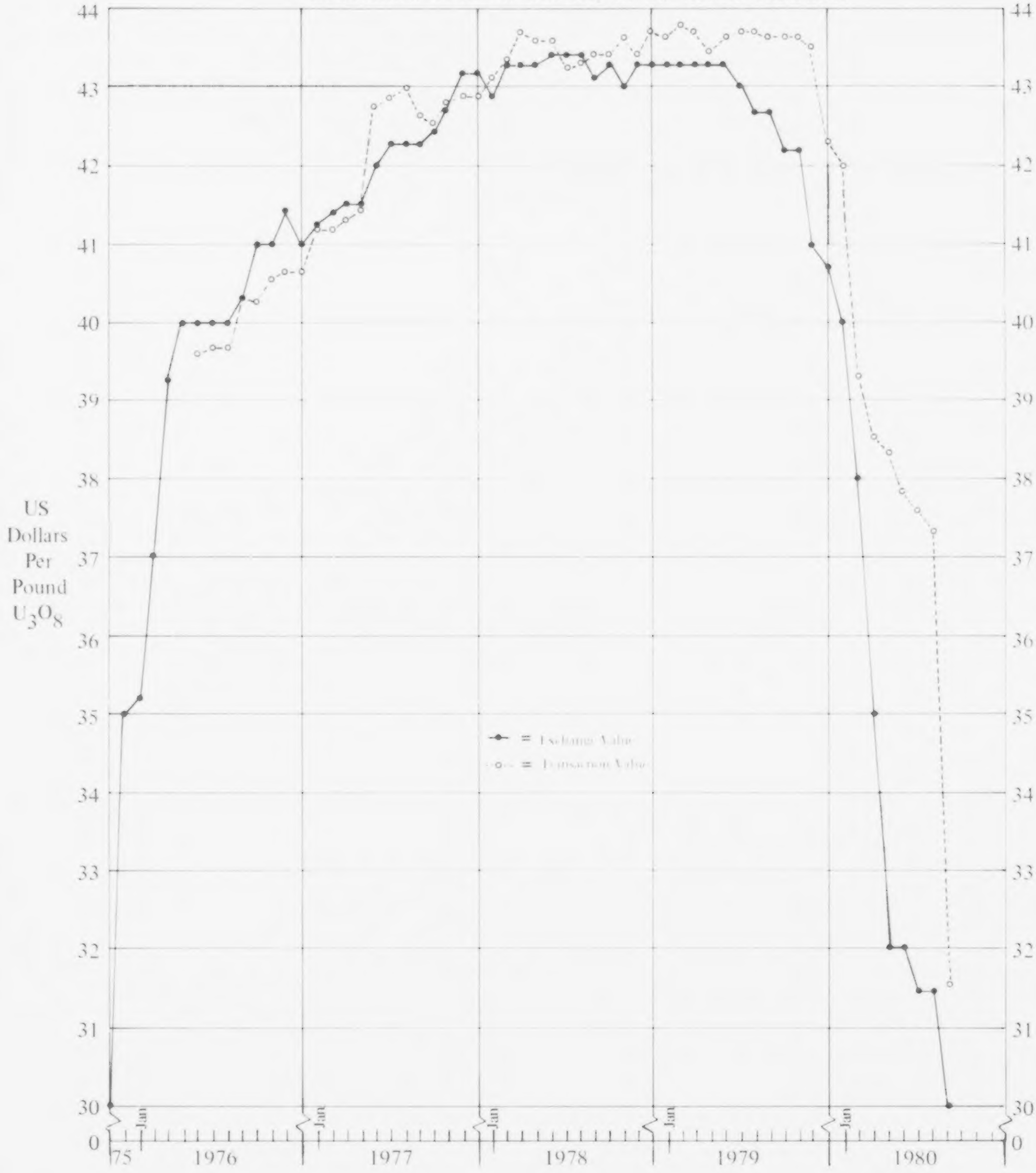
Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES SINCE NOVEMBER 1975

Determined as of the last day of the month indicated



STATISTICAL DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated
(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00				

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated
(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60				

Note: See Nuexco Report 135 for a discussion of the definition of Transaction Value.

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	30.00	66.14	77.99
France (franc)	124.74	275.00	324.30
FRG (mark)	53.64	118.25	139.45
Japan (yen)	6,543	14,425	17,011
Switzerland (franc)	49.37	108.83	128.34
UK (pound)	12.55	27.67	32.63
Australia (dollar)	25.82	56.92	67.12
Canada (dollar)	34.76	76.63	90.36
Niger, Gabon (CFA)	6,237	13,750	16,215
South Africa (rand)	22.68	49.99	58.95

*Calculated using currency exchange rates published in the Wall Street Journal on the last Friday of the month

LOAN USE CHARGE RATE—7.0% year

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Nuexco Reference Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as percent of Current E.V.	Seller Group	Buyer Group	Remarks
1175	80	601 – 1000	101	Canada	US	
1179	80	1 – 50	100	US	US	
1180	80	51 – 100	99	US	US	
1183	81	1 – 50	<102	Europe	Far East	Exact price information not available
1186	80	101 – 300	103	US	US	
1187	80-81	51 – 100	101	US	US	
1189	80	101 – 300	107	US	Europe	
1190	80-81	1 – 50	102	US	US	
1191	81-89	1001 – 2000		Australia	Europe	Definitive price information not available
1192	80	1 – 50	108	US	Far East	

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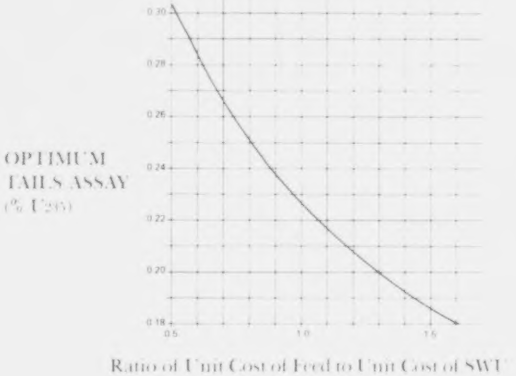
* Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

OPTIMUM TAILS ASSAY

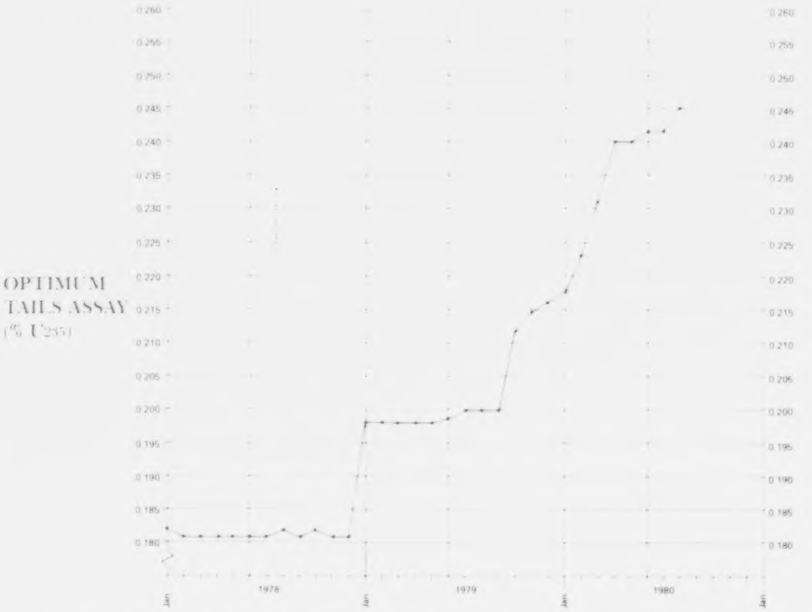
The optimum tails assay is the tails composition at which the cost of enriched uranium is lowest for given costs of separative work (SWU) and natural uranium feed. It depends only on the ratio of the cost of a kilogram of natural uranium in the form of UF_6 to the cost of a kilogram unit of separative work. The US Department of Energy (USDOE) Adjustable Fixed Commitment (AFC) enrichment contract holders have the option, within limits, to specify the transaction tails assay. The transaction tails assay for USDOE Requirements contracts is 0.2 percent U_{235}. For every one-hundredth of one percent increase in the transaction tails assay, uranium consumption increases about two percent.

TAILS ASSAY FOR MINIMUM COST OF PRODUCT*



*From Nuexco Report 138

HISTORICAL OPTIMUM TAILS ASSAY[1]



[1]Based on Exchange Value and USDOE AFC SWU price; interpolated to the nearest thousandth.

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 199)[1]	Consumer Price Index (1967 = 100)[2]	GNP Implicit Price Deflator (1972 = 100)[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]		
				Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)
Annual Avg. 1970 (5)	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971 (5)	114.1	121.3	96.02	4.12	4.15	3.97
Annual Avg. 1972 (5)	117.9	125.3	100.00	4.56	4.59	4.26
Annual Avg. 1973 (5)	125.9	133.1	105.80	4.84	4.98	4.51
Annual Avg. 1974 (5)	153.8	147.7	116.02	5.44	5.63	4.88
Annual Avg. 1975 (5)	171.5	161.2	127.15	6.13	6.24	5.39
Annual Avg. 1976 (5)	182.4	170.5	133.71	6.76	6.87	5.91
Annual Avg. 1977 (5)	195.1	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978 (5)	209.4	195.4	152.05	8.23	8.56	7.01
Annual Avg. 1979	236.5	217.4	165.46	9.27	9.50	7.59
May 1979	231.6	214.1		9.06	9.15	7.47
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9		9.32	9.57	7.60
Aug 1979	240.6	221.1		9.38	9.70	7.65
Sep 1979	244.2	223.4	167.20	9.63	9.79	7.73
Oct 1979	249.0	225.4		9.67	9.87	7.82
Nov 1979	250.6	227.5		9.79	9.86	7.87
Dec 1979	253.1	229.9	170.58	9.80	9.92	7.91
Jan 1980	260.6	233.2		9.92	10.06	7.96
Feb 1980	265.4	236.4		9.93	10.01	7.99
Mar 1980	268.2	239.8	174.48	9.91	10.23	8.04
Apr 1980	270.7	242.5		10.00	10.30	8.12
May 1980	271.2P	244.9		10.18	10.37	8.17
Jun 1980	273.0P	247.6	178.93	10.21P	10.70P	8.22P
Jul 1980	275.6P	247.8		—		8.35P

P = Preliminary R = Revised since last month

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, DC.; "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. Data for January 1977 through March 1980 are adjusted to the March 1978 benchmark. Data for April 1980 and beyond are adjusted to the most recent benchmark—March 1979.

(5) Data for 1970-1978, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Nuexco Report 139.

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry—All Groups (Year 1968-69 = 100.0)[1]	Weighted Average Minimum Weekly Wage Rates—Adult Males Australia Mining and Quarrying (A$)[2]
Annual Avg. 1970 (3)	101.4	59.88
Annual Avg. 1971 (3)	101.5	65.95
Annual Avg. 1972 (3)	105.6	71.26
Annual Avg. 1973 (3)	124.4	78.96
Annual Avg. 1974 (3)	141.9	108.07
Annual Avg. 1975 (3)	150.4	132.55
Annual Avg. 1976 (3)	168.4	160.93
Annual Avg. 1977 (3)	192.0	179.03
Annual Avg. 1978 (3)	215.4	190.04
Annual Avg. 1979	248.5	196.34
Mar 1979	264.0	191.64
Apr 1979	274.0	192.46
May 1979	288.5	193.56
Jun 1979	294.9	196.64
Jul 1979	298.2	199.22
Aug 1979	293.2	200.29
Sep 1979	302.4	201.07
Oct 1979	309.4	200.53
Nov 1979	310.4	199.84
Dec 1979	319.4	200.65
Jan 1980	340.1	215.31
Feb 1980	345.6	214.78
Mar 1980	340.3	214.22
Apr 1980	327.9	214.53
May 1980	335.1P	214.07
Jun 1980	338.4P	

P = Preliminary R = Revised since last month

(1) Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

(2) Australian Bureau of Statistics, Canberra: "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest fourteen months shown are subject to revision.

(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Nuexco Report 138.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000)[1,2] (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings (C$)[3,4]		
		Metal Mining, including milling (SIC 050-059)	Primary Metal Industries, non-ferrous (SIC 296-298)	Chemicals and Chemical Products (SIC 370-379)
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Annual Avg. 1979	217.9	9.60	7.35	7.67
Apr 1979	212.8	9.68	7.26	7.63
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3	9.37	7.34	7.73
Aug 1979	220.0	9.56	7.38	7.77
Sep 1979	223.4	9.75	7.50	7.81
Oct 1979	227.4	9.89	7.54	7.88
Nov 1979	228.1	9.97	7.61	7.91
Dec 1979	230.4	9.93	7.51	7.89
Jan 1980	238.9	9.96	7.57	7.99
Feb 1980	240.7R	10.11	7.69	8.08
Mar 1980	239.4	10.34	7.83	8.26
Apr 1980	241.0R	10.40P	7.94P	8.36P
May 1980	243.0	10.49P	8.02P	8.44P
Jun 1980	244.0P	—	—	

P = Preliminary R = Revised since last month

(1) Statistics Canada, Prices Division, Ottawa: "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 1.10 of Nuexco Report 138.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa: "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 1.11 of Nuexco Report 138.

STATISTICAL DATA

REPUBLIC OF SOUTH AFRICA STATISTICS

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100, except where otherwise indicated)
Annual Avg. 1970(3)	7.34	100.3(4)
Annual Avg. 1971(3)	7.88	106.4(4)
Annual Avg. 1972(3)	8.79	113.3(4)
Annual Avg. 1973(3)	10.51	124.1(4)
Annual Avg. 1974(3)	13.18	138.5(4)
Annual Avg. 1975(3)	16.71	157.2(4)
Annual Avg. 1976(3)	19.30	174.7(4)
Annual Avg. 1977(3)	23.87	194.4(4)
Annual Avg. 1978(3)	27.14	137.2
Annual Avg. 1979(3)	30.18	155.3
May 1979	—	150.6
Jun 1979	29.44	152.4
Jul 1979	—	157.9
Aug 1979		160.2
Sep 1979	30.71	162.1
Oct 1979	—	162.9
Nov 1979	—	163.4
Dec 1979	31.89	164.0
Jan 1980	—	165.4
Feb 1980	—	167.0
Mar 1980	33.65	168.0
Apr 1980	—	170.0
May 1980	—	171.9
Jun 1980	34.08	174.6
Jul 1980	—	—

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(1) Chamber of Mines of South Africa, Johannesburg: "Analysis of Working Results," published quarterly.
(2) Republic of South Africa Department of Statistics, Pretoria: "Government Gazette: Consumer Price Index for Urban Areas."
(3) Historical data for 1970 through 1979 appear on page 1.9 of Nuexco Report 140.
(4) April 1970 = 100.00

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM SUPPLY

Nuexco Reference Number	Thousands of Pounds U_3O_8				Remarks
	1980	1981	1982	1983	
Available for Sale:					
1236			150	150	
1274	200				
1284	250				
1286		150	250	250	
1315			200	200	
1325	750				
1338	250				
1392	300				
1394	250				
1417	1000				UF_6
1475	500				
1476	250	250			
1479	200				
1481		250			
TOTALS	3950	650	600	600	
Available for Loan:					
1175	700				UF_6
1234	700				
1354	600				UF_6
1355	600				
1429	500				
TOTAL	3100				

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM DEMAND

Nuexco Reference Number	Thousands of Pounds U_3O_8				Remarks
	1980	1981	1982	1983	
Inquiries to Purchase:					
1146		100	200	200	
1321		100	300	300	
1408	150				
1410		2000	2000	2000	
1459			200	200	
1462				100	
1470	25				
TOTALS	175	2200	2700	2800	
Inquiries to Borrow:					
1220	500				

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the secondary market for UF_6 conversion services. The data presented in this section are in no way intended to be indicative of the entire market for the time period covered.

CONVERSION SUPPLY

Nuexco Reference Number	Thousands of Pounds U as UF_6 1980	1981	1982	1983	Remarks
P-1282	250	250			
P-1417	1000				
P-1449		750			
P-1450	750				
P-1451	175				
P-1474	50				
P-1484	2000	1000	3000	1000	
TOTALS	4225	2000	3000	1000	

CONVERSION DEMAND

Nuexco Reference Number	Thousands of Pounds U as UF_6 1980	1981	1982	1983	Remarks

NUEXCO
NUCLEAR EXCHANGE CORPORATION

3000 SAND HILL ROAD
MENLO PARK, CALIFORNIA 94025

EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT 145

The **Exchange Value** dropped to \$30.00 per pound U_3O_8, down from \$31.50 last month. Competition by non-US producers to sell in the US market were primarily responsible for the downward price pressure. Some inventory holders stepped up their efforts to sell, thus providing an additional downward influence on prices.

The market was relatively active this month as ten transactions closed. Significant among them was a relatively large near-term sale by a Canadian producer to a US utility. Also, three transactions closed this month involving US utilities as sellers. Queensland Mines, Ltd. of Australia announced a long-term contract involving the sale of 1.8 million pounds U_3O_8 to TVO of Finland.

The **Australian** government announced the initialing of a series of contracts involving the sale of about 68 million pounds U_3O_8 from Ranger. These sales are in connection with the formation of Energy Resources of Australia (ERA) and the sale of the Australian Government's equity in Ranger. The purchasers are utilities and other firms in **Japan** and the **Federal Republic of Germany.**

The **US** Nuclear Regulatory Commission voted to issue a full power operating license to Virginia Electric and Power Company for its North Anna unit 2. This is the first full power license issued in the US since the Three Mile Island accident.

The US Department of Energy's determination of the average price of uranium paid by US utilities in 1979 was \$23.85 per pound U_3O_8.

This Report contains a revised Nuexco forecast of **US uranium production.** Nuexco expects that US production will decline from the 1979 level of about 37 million pounds U_3O_8 to about 34 million pounds in 1980, and to about 20 million pounds by the mid-1980's. The expected decrease is due to declining ore grades, depletion of orebodies, and production cutbacks resulting from high user inventories and competition from non-US producers.

This Report also contains a re-assessment of the uranium **supply/demand balance** through 1990. Because of reduced estimates of future consumption, especially in the US, world commercial uranium inventory levels are expected to remain very high, at about three years forward consumption throughout the period of the estimate.

This month's *Topical Essay* focuses on the past economics of the US uranium industry, as a guide in predicting future US production levels.

The *Raw Materials* section discusses the uranium production picture in **Argentina.**

This Executive Summary may be reproduced for internal distribution.

9/80

NUEXCO

OCTOBER 1980 **NUMBER 146**

10/10/80 B 6800-1 U

Monthly Report on the Uranium Market

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NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

October 1980 No. 146

JAMES E. VAUGHAN, *EDITOR*

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FOREWORD

Nuexco will host a luncheon at the Atomic Industrial Forum annual meeting at the Washington Hilton on Monday, November 17, 1980. Invitations will be sent out shortly; please reserve the date.

An index of topics covered in the Nuexco Monthly Report over the last twelve months is included at the end of this Report. The index will be updated on a continuing basis in each Monthly Report.

Table 11 of Report 145 was garbled somewhat in typesetting. A new Table 11 is included as an insert to this Report.

It is a pleasure to announce that Mr. G. Brian Grega has joined the Nuexco staff this month as an Associate. Brian is a recent graduate of the University of California at Berkeley, where he majored in economics.

URANIUM MARKET

AUSTRALIA

Information on the structure, finances and sales of Energy Resources of Australia (ERA) will become available from the prospectus relating to its offering of some 57 million shares of stock to the Australian public. Some details now available are as follows:

1. ERA will be capitalized at 500 million shares of which only 405.9 million shares will be initially issued as follows:

	Millions of Shares	Percent
PEKO-Wallsend	125	30.8
EZ Industries	125	30.8
Japan-Australia Uranium Resource Development Company, Ltd. (JAURD)	41	10.1
Urangesellschaft	16.4	4.04
Rheinische Braunkohlenwerke (A subsidiary of RWE)	25.625	6.31
Saarberg-Interplan	15.375	3.79
Australian Public	57.5	14.16
Totals	405.9	100.00

2. 4.1 million shares will be held in reserve for issue to a utility which is expected to enter into a long term contract to purchase U_3O_8 from ERA. However, negotiations for this issue, which would be equivalent to one percent of then outstanding shares, have yet to be undertaken.
3. Japan-Australia Uranium Resource Development Company, Ltd. (JAURD) is jointly held by Kansai Electric (50 percent), Kyushu Electric (25 percent), Shikoku Electric (15 percent) and C. Itoh and Company (10 percent). C. Itoh will manage JAURD.
4. The initial overseas owners will hold 98.4 million shares or 24.2 percent of ERA for which they will pay A$98.4 million.
5. Project financing will be provided by loans from JAURD (US$140 million), a consortium of banks headed by J. Henry Schroder-Wagg and Continental Illinois (US$250 million), Peko Wallsend and EZ Industries (US$30 million each). The loans are repayable over approximately eight years following project start up.
6. U_3O_8 sales to the new shareholders totaling 67.5 million pounds U_3O_8 and other ERA commitments totaling 16.2 million pounds are shown in Table 1. This is a revision of the data presented in Nuexco Report No. 145.
7. Contracts with the foreign shareholders extend over 15 years. Prices are fixed for 1982 delivery; are subject to escalation for 1983 and 1984 delivery; and, in 1985 and later, are based on international market prices subject to an escalating floor price. Escalation is based on Australian labor and material indexes and applies to less than 100 percent of the base price. Deliveries may be terminated after 1990 if prices paid have exceeded market price at the time of delivery over some predetermined period of time. Provisions also exist for cessation of escalation of the floor price if it exceeds market price. Although the floor price mechanism is rigid there is a debit and credit system. Under the system, the buyer can accumulate paper credits during a period in which the floor price is higher than market price. The paper credits can be recouped at such later time as market price exceeds floor.
8. Sales other than to ERA participants are for varying periods of time up to 13 years, at prices related to market subject to floors. Some contracts contain provisions for termination of deliveries if prices actually paid exceed market price at delivery.
9. All sales have been made in US dollars.

The Ranger mill is designed to process 3850 short tons per day at a head feed grade of 0.30 percent U_3O_8, producing 6.6 million pounds U_3O_8 annually, and is scheduled to commence commercial operations in October 1981. In order to meet 1982 delivery commitments, the mill will have to start up on time and operate at or close to full-rated output.

In a separate development Canada's Denison Mines, Ltd. has won approval from the Australian government to purchase the Koongarra deposit from Noranda Mines, Ltd. This transfer is from one Canadian entity to another, and does not alter the Australian requirement for 75 percent Australian equity prior to development. Denison will face the same aboriginal, environmental and related problems that have stalled Noranda in developing Koongarra.

Western Mining Corp., Ltd. has commenced operation of its Kalgoorlie Research Plant in Western Australia. The plant is the principal part of the first stage of development of the Yeelirrie project. It was built as a pilot plant for testing the Yeelirrie

Table 1

ENERGY RESOURCES OF AUSTRALIA (RANGER) SALES COMMITMENTS, BY YEAR

(thousands of pounds U_3O_8)

	1981/1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
American Electric Power Co.	500	500	500	500	500	500	500	500	500	—	—	—	—	—	—
Korea Electric Co.	—	500	500	500	500	500	500	500	500	500	500	—	—	—	—
Federal Republic of Germany[1]	2,100	2,240	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800
JAURD	1,200	1,200	1,500	1,500	1,500	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Other Japanese Contracts[2]	1,760	600	600	600	800	—	—	—	—	—	—	—	—	—	—
Repayment of loan to Australian Government	1,000	1,000	228	—	—	—	—	—	—	—	—	—	—	—	—
Contracts under negotiation	50	50	50	300	300	300	300	300	300	300	300	300	300	—	—
Totals	6,610	6,090	6,178	6,200	6,400	6,100	6,100	6,100	6,100	5,600	5,600	5,100	5,100	4,800	4,800

[1] The three participants in ERA from the Federal Republic of Germany are Urangesellschaft, Saarberg-Interplan and Rheinische Braunkohlenwerke, a subsidiary of RWE.

[2] These contracts with Kyushu Electric and Chubu Electric were first signed in the early 1970's.

metallurgical circuit on a continuous basis. About 8,000 tonnes of ore will be processed through the plant in the first phase. Figure 1 is an overview of plant. Figure 2 is a closeup of the concentrate thickeners.

CANADA

The uranium industry in Canada continues in a relatively positive stance regarding exploration and production. At Elliot Lake, Rio Algom, Ltd. continues in its expansion program to bring the Stanleigh facility back into production after 20 years of dormancy. This will bring Rio Algom's total mining and milling capacity at Elliot Lake up to 15,000 tons per day when completed. The current schedule calls for completion by 1984.

Denison Mines, Ltd. is also continuing development to attain 15,000 tons per day capacity. In addition, Denison has moved to acquire the Koongarra deposit in Australia's Northern Territory from Noranda Mines, Ltd.

In Saskatchewan, Gulf Minerals Canada, Ltd. (GMCL) and its partner Uranerz Canada, Ltd. continue in their aggressive program of production and exploration. The Rabbit Lake production center, which produced approximately 5.4 million pounds U_3O_8 in 1979 at an average grade of 0.39 percent, is expected to continue to run long after the reserves in the Rabbit Lake mine are exhausted. It is currently estimated that about half of the 40 million pounds of reserves at Rabbit Lake have been mined out since the facility began operating in 1975. However, reserves estimated at an additional 50 million pounds U_3O_8 have been discovered at Collins Bay, about six miles northeast from Rabbit Lake. GMCL plans to begin feeding Collins Bay ore to the Rabbit Lake mill as early as 1982 if government approval can be obtained by then. GMCL's latest discovery is at Eagle Point, about eight miles north of Rabbit Lake. The ore grade of both Collins Bay and Eagle Point is estimated to be about 0.40 to 0.50 percent U_3O_8.

Canadian producers continue their presence in the US uranium market and elsewhere, and will probably continue to compete for near and longer term sales.

The chairman of Canada's Royal Commission on Electric Power Planning has announced his support of the expansion of nuclear power in Canada. Dr. Arthur Porter is calling for the aggressive implementation of nuclear power throughout Canada, not only for domestic use, but also for export of electric power to the US. Dr. Porter's position has changed considerably since the formal issuance of the Royal Commission's recommendations in March, 1980. At that time, the Commission took a much more cautious view of nuclear power expansion in Canada.

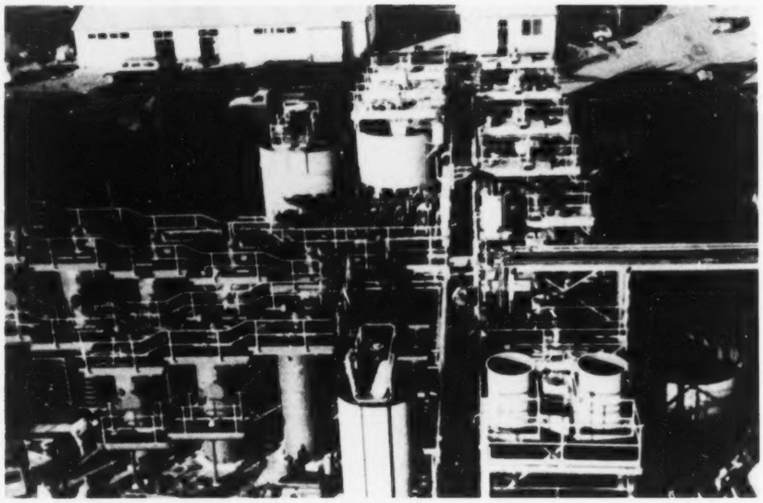

Figure 1
THE PILOT PLANT RECENTLY COMMISSIONED BY WESTERN MINING CORP. IN WESTERN AUSTRALIA. THE PLANT WILL BE USED TO TEST ORE FROM YEELIRRIE.

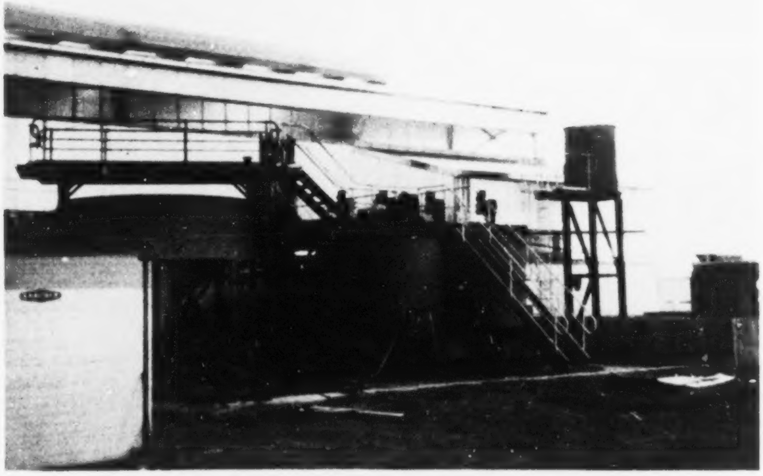

Figure 2
CLOSEUP OF THE CONCENTRATE THICKENERS.

A bill has been introduced into the Canadian House of Commons which would severely limit the enforceability of foreign antitrust judgments in Canada. The bill, entitled the Foreign Proceedings and Judgments Act, would empower Canada's Attorney General to prohibit or restrict disclosure of Canadian business records in foreign antitrust proceedings, and to declare foreign antitrust judgments unenforceable in Canada. The act would also enable Canadian citizens to sue in Canadian courts to recover amounts paid in antitrust judgments outside of Canada.

EUROPE

France has reached an accord with Australia on a bilateral agreement under which the French may import Australian uranium. The agreement has been approved at the cabinet level of both nations, and will be submitted to both governments for ratification. The agreement requires that Australian uranium be used only for peaceful purposes. Also, the Australian safeguards code calls for Australia to maintain the prior right of approval for reprocessing and resale. Euratom has not yet signed an agreement with Australia, mainly due to the prior approval issue. The draft agreement between France and Australia will be submitted to Euratom headquarters in Brussels, in accordance with Euratom policy.

A referendum was recently held in the canton of Zurich in **Switzerland** concerning the Kaiseraugst nuclear power project. Voters narrowly endorsed the project by a vote of 51 percent in favor and 49 percent opposed. The referendum was styled "consultative only," and is not legally binding since the Kaiseraugst site is not located in the canton of Zurich. However, the vote is expected to have some political influence on the Swiss Parliament, which has final authority to approve the project.

FAR EAST

During August 1980, **Japan's** 21 commercial nuclear power plants established record levels for availability and utilization. These plants, representing a total capacity of about 15,000 MWe, had an availability factor of 81.5 percent and a capacity factor of 73.5 percent.

Tokyo Electric received approval for units 3 and 4 at its Fukushima II station. These will be 1100 MWe boiling water reactors, one to be supplied by Toshiba and the other by Hitachi. Start-ups are scheduled for 1985.

An update of Japan's participation in the Ranger project is contained in the Australia section of this Report.

UNITED STATES

Senator Peter Domenici (Republican, New Mexico) introduced an amendment to the 1981 appropriations bill for the US Department of Energy (USDOE) which contained language aimed at limiting use of imported uranium in US reactors. The amendment was deleted by a House-Senate conference committee. This action and the issue of embargoes in general are discussed in the *Commentary* section of this Report.

The September 23, 1980 referendum vote in Maine to close the Maine Yankee nuclear power plant was soundly defeated by a three to two margin. There are five other antinuclear initiatives scheduled for November of this year. The states involved are Mississippi, Oregon, Montana, Washington and South Dakota. In Mississippi and Oregon, the initiative would require voter approval for nuclear power plant licensing, construction or operation until a federal waste disposal facility is in existence. The Montana initiative would forbid the disposal of wastes produced by milling or other methods of processing ore in the state. The Washington state initiative would prohibit the importation of high-level waste from other states unless otherwise permitted by interstate compact. The initiative proposed in South Dakota would require a popular vote prior to starting any uranium mining or other nuclear development project.

The US Senate voted 48 to 46 in favor of exporting 40,000 kilograms of enriched uranium to India for fueling the Tarapur nuclear power plant. President Carter assured the Senate that no subsequent deliveries of material will be shipped unless India agrees to safeguard inspections. The House had previously voted against the shipments to India by a margin of 298-98. However, under the US Nuclear Nonproliferation Act of 1978, a resolution of both houses is required to override the President's decision to overrule the US Nuclear Regulatory Commission (NRC). President Carter had previously overruled the USNRC, which had voted against the export to India because India does not permit full scope inspection of its nuclear power program.

Exploratory uranium drilling in the US could be down as much as 35 percent in 1980, based upon preliminary midyear drill footage. An estimated nine million feet were drilled in the first half of 1980 down from 14 million feet in the first half of 1979.

The weak uranium market continues to take its toll on US uranium production as additional cutbacks and delays were announced this month. Development of the Hansen ore body in Colorado has been delayed indefinitely. The deposit is jointly owned by Amoco Minerals and Wyoming Minerals. Also, Kerr McGee Nuclear Corporation announced a two year delay in the development of its Powder River Basin deposits in Wyoming. Excessive government regulations were cited by Kerr McGee, in addition to the weak market for uranium. Additional layoffs in Wyoming were announced by both Pathfinder Mines Corp. and Federal-American Partners. Finally, Western Nuclear, Inc. is closing its Sheep 1 underground mine near Jeffrey City, Wyoming. The mine will be kept in standby condition and could be reopened in the event that market conditions improve.

USDOE issued its annual "Survey of United States Uranium Marketing Activity" this month. The report is a compilation of responses to a survey among US uranium industry participants. The data reported by USDOE in the survey include estimated US uranium production potential for the years 1980 through 1990. It is interesting to compare these figures with Nuexco's forecast of US production. The comparison is tabulated in Table 2 for the years 1980 through 1983. As indicated, the USDOE figures for US production potential are much higher than the Nuexco forecast of US production. The reasons for the difference include the following:

1. The USDOE survey was taken when the uranium market was stronger than it is now. Much of the material listed under the column heading "Available for Sale" will probably not be produced.
2. Many existing supply contracts are known to have flexibility provisions which allow the rescheduling of deliveries to later years. Also, some market price contracts have floor price provisions which allow the seller the option to cancel deliveries if market price is below the floor.
3. Some supply contracts are *requirements* type, under which the seller has the obligation to supply the buyer's requirements based on certain ground rules. Other contracts are *output* type, under which the seller has the obligation to deliver only if the production facility produces. In the case of both requirements and output contracts, actual performance is often different from what might be predicted.
4. Continuing litigation in the uranium industry can be expected to result in many deliveries not being made. For example, according to the USDOE survey, about eight million pounds U_3O_8 listed under 1980 sales commitments are characterized as "under litigation."
5. The nature of USDOE data gathering for this publication can affect the results somewhat. Answers to surveys are often "official" company positions, as opposed to estimates of what will most likely happen.
6. Many US producers are now considering purchasing on the open market to deliver under existing supply contracts, rather than produce the material themselves. This is another effect directly attributable to the weakened market.

Nuexco's forecast of US production is based on the probable reactions of the participants in the industry to the current uranium market situation. The continuing stream of announced delays, cutbacks and shutdowns in the US industry indicates of the degree of retrenchment to be expected.

Also of interest in the USDOE survey is the degree to which delays and cancellations of US nuclear power plant projects show up in utility reports of uranium requirements. According to the USDOE survey, unfilled uranium requirements of US utilities were 75,700 tons U_3O_8 as of January 1, 1980. This is compared to 176,000 tons as of January 1, 1978, and 135,100 as of January 1, 1979. The main reasons for the drop are cancellations and delays of reactor projects, rescheduling resulting from conversion to the adjustable fixed commitment enrichment con-

Table 2
COMPARISON BETWEEN USDOE SURVEY OF US PRODUCTION POTENTIAL AND NUEXCO FORECAST OF US PRODUCTION
(millions of pounds U_3O_8)

	USDOE Survey[1] Results			
Year	**Sales Commitments**	**Available for Sale**	**Total US Production Potential**	**Nuexco Forecast of US Uranium Production[2]**
1980	47.0	5.2	52.2	35
1981	42.0	6.2	48.2	31
1982	40.8	8.6	49.4	29
1983	36.6	14.2	50.8	27

[1] George F. Combs, Jr. and S. Victoria Krusiewski: "Survey of United States Uranium Marketing Activity," USDOE; Washington, D.C.; July, 1980; USDOE/RA-0053.

[2] Nuexco Report 145, Table 7.

tract, and new contracts for uranium supply signed during 1978 and 1979.

Average uranium prices as reported by the utilities in the USDOE survey are as follows:

Year	**Average Price (dollars per pound U_3O_8)**
1979	23.85
1980	25.40
1981	30.45
1982	32.55

These prices include market price contracts to the extent that settlements have already been made. The prices are expressed in year of delivery dollars. To the extent that these average prices include contracts under litigation, the data may be somewhat skewed to the low side. In any case, when these prices are compared to Nuexco's estimates of US production costs (see Nuexco Report Number 142, page 12), it suggests that the US uranium industry, on the average, is not operating profitably. Nuexco estimates that the median full cost of production in the US uranium industry is currently about $30.00 per pound U_3O_8.

TRANSACTIONS

Three transactions closed this month. All were traditional producer to utility sales. A US producer sold between 100,000 and 300,000 pounds U_3O_8 for near term delivery to a European utility. Another US producer sold a quantity between 600,000 and one million pounds U_3O_8 to a US utility for delivery over the period 1981-85. Finally, a US producer sold between 50,000 and 100,000 pounds U_3O_8 to a European utility.

PRICING

September's market action resulted in a further decline of the **Exchange Value** to $28.50 per pound U_3O_8, and followed the general pattern seen during the previous several months. Sellers outnumber buyers, and the material available for sale was in excess of quantities being sought. Sellers have therefore been competing vigorously for each new piece of business. The situation has been exacerbated by non-conventional sellers, utilities and other inventory holders.

The momentum of the decline in prices may be beginning to ease, however. The nature of the active bids and offers in the market could signal the approach of some stability in prices. The prices of current spot bids are low but fixed. Some bids for near term material are also at fixed prices. This represents a change from a few months ago when bids for near term delivery often included adjustments for declines in market price.

In addition, the market is becoming somewhat more balanced than it has been in the recent past. Inquiries to sell within the next 12 months (i.e. spot and near term material) total about 4.7 million pounds U_3O_8. Inquiries to purchase within the next 12 months total about two million pounds. Non-US utilities are taking advantage of current prices to purchase spot and near term quantities from US sellers. Also, at least one US utility has decided to enter the near term market. Several US utilities are active in the intermediate and long term markets, but only a few deals have in fact been closed recently.

The **Transaction Value** decreased this month to $30.60 per pound U_3O_8.

CONVERSION

No transactions closed this month in the secondary market for conversion services. However, an inquiry surfaced this month for a large quantity of conversion, with UF_6 delivery scheduled for 1981. Nuexco estimates that transactions for conversion services can be completed in the secondary market for about $1.50 per pound U as UF_6.

TOPICAL ESSAY

THE CURRENT URANIUM MARKET: HAVE WE BEEN THERE BEFORE?

Hardly a week passes in recent times without some announcement or rumor of layoffs, cutbacks or shutdowns in the US uranium production industry. Nearly all US producers have announced cutbacks because of the weak market, and many new projects have been delayed or cancelled. Nuexco estimates that more than fifty percent of US production is being produced at a cost greater than recent Exchange Value levels.

Today's Market Compared to the Early 1970's

It has been observed by some that the current depressed state of the uranium industry is similar in many ways to the depression of the early 1970's. The average Nuexco Exchange Value for 1972 was $5.95 per pound U_3O_8, and few, if any, producers were profitable. Few long term contracts were being signed at that time apparently due to a perception by buyers of an ample supply of uranium, relative to demand. A very strong buyers' market prevailed.

It is worthwhile to focus on one similarity between the market of the early 1970's and today's market; a similarity which has only recently become apparent. US consumption in the early 1970's was low in relation to US production. However, it was then projected that uranium consumption would increase rapidly, and thus US demand would soon outstrip US production capacity. For example, a projection[1] by the US Atomic Energy Commission (AEC) of US demand published in April 1973 showed that demand would equal the then-current US production rate within two years, and would exceed the then-current US production rate by some 25 million pounds annually within five years. The demand projection was based on what proved to be a highly optimistic projected growth rate of US installed nuclear capacity. However, the apparent result at that time was that US buyers began to perceive a uranium supply crunch. This perception, combined with the implementation by the USAEC of the fixed-commitment enrichment contract, led to an unprecedented increase in buying activity in 1973, when requests for offers for future uranium deliveries issued by US utilities amounted to over 320 million pounds U_3O_8. Prices responded by moving higher.

The US supply/demand situation outlined above for the early 1970's is, *per se*, not very much different from that outlined in Nuexco Report 145 for the current market. The tables from Report 145 containing world and US supply/demand data are reproduced here as Table 3 and Table 4. Table 4 indicates that current US consumption of uranium is low, relative to US production. 1980 consumption is estimated by Nuexco at 18.1 million pounds U_3O_8, compared to 1980 US production of 34.5 million pounds U_3O_8. Further, the same table shows Nuexco's estimates of US production about equal to US consumption in 1982, only two years hence (production of 28.5 million pounds, consumption of 29.9 million pounds). Finally, the table shows US consumption rising above US production in the mid-1980's by more than 20 million pounds annually. The reasons for the projected falloff in US production, discussed in Report 145, are related principally to current and expected weak market conditions, and not to any shortfall in US uranium resources.

Thus many veterans of the uranium industry are viewing today's market situation as something very much like what they have seen before. Even the apparent new low-cost production from non-US sources was foreseen in the early 1970's. At that time, the deposits in Australia's Northern Territory and some in Canada's northern Saskatchewan district had already been discovered.

The question that naturally follows from these similarities is whether the market can be expected to recover in the way it did in the mid-1970's. The answer, as is usually the case in the behavior of a commodity market, will revolve around market perceptions.

Market Perceptions—A Look at the Copper Market

Market prices for most commodities tend to vary in roughly a cyclical pattern. As perceived supply grows relatively short, prices tend to increase. Similarly, when market participants view supply as abundant, prices tend to ease. The copper market is a mature market in comparison to uranium, and it might be instructive to trace how changes in perception in the copper market can translate to price movements.

The copper market was in the doldrums just two years ago. In 1978, world inventories of copper were relatively high, especially the very visible inventories in the London Metal Exchange (LME) and the

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[1] Survey of United States Uranium Marketing Activity," USAEC; Washington, D.C.; April, 1973; WASH-1196(73).

TOPICAL ESSAY

Table 3
NATURAL URANIUM SUPPLY-DEMAND BALANCE: WOCA[1]
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[2]												
Operating Production Centers	98.5	103.3	105.8	104.3	104.8	104.1	101.1	100.1	99.2	99.0	99.0	99.0
Facilities under Construction	-0-	0.6	6.4	8.9	12.9	17.7	19.8	20.8	20.6	20.6	20.6	20.6
Total	98.5	103.9	112.2	113.2	117.7	121.8	120.9	120.9	119.8	119.6	119.6	119.6
less												
CONSUMPTION[3]	68.7	57.7	74.1	85.3	93.9	100.2	113.4	112.5	113.7	114.1	115.0	114.1
equals												
NET INVENTORY INCREASE	29.8	46.2	38.1	27.9	23.8	21.6	7.5	8.4	6.1	5.5	4.6	5.5
plus												
BEGINNING INVENTORY	160.0[4]	189.8	236.0	274.1	302.0	325.8	347.7	354.9	363.3	369.4	374.9	379.5
equals												
ENDING INVENTORY	189.8	236.0	274.1	302.0	325.8	347.4	354.9	363.3	369.4	374.9	379.5	385.0
RELATIVE INVENTORY[5] (yrs)	2.3	3.3	3.2	3.2	3.2	3.3	3.1	3.2	3.2	3.3	3.3	3.3

[1] World outside Communist areas.
[2] Nuexco Report 145, Table 9.
[3] Natural uranium entering enrichment-fabrication pipeline for later use in a reactor. Nuexco Report 144, Table 1.
[4] Nuexco Estimate.
[5] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Table 4
NATURAL URANIUM SUPPLY-DEMAND BALANCE: US
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[1]												
Operating Production Centers	37.0	34.2	29.3	26.0	24.7	22.0	19.0	17.1	16.3	16.2	16.2	16.2
Facilities Under Construction	-0-	0.3	2.0	2.5	2.7	3.0	3.0	3.0	2.8	2.8	2.8	2.8
Total	37.0	34.5	31.3	28.5	27.4	25.0	22.0	20.1	19.1	19.0	19.0	19.0
less												
CONSUMPTION[2]												
Reactors Now Operational	16.3	17.4	17.4	17.1	18.0	18.0	18.1	17.4	17.6	18.3	18.2	17.7
Now Under Construction	8.5	0.7	7.5	12.8	17.2	22.2	25.4	30.0	27.1	30.3	27.2	27.6
Now On Order	-0-	-0-	-0-	-0-	-0-	-0-	-0-	0.9	0.3	0.3	3.4	2.0
Total	24.8	18.1	24.9	29.9	35.2	40.2	43.5	48.3	45.0	48.9	48.8	47.3
plus												
NET IMPORTS (EXPORTS)[3]	(1.8)	(1.9)	0.3	1.5	1.2	1.7	0.1	0.6	0.6	0.6	1.0	1.1
equals												
SUPPLY SURPLUS (DEFICIT)	10.4	14.5	6.7	0.1	(6.6)	(13.5)	(21.4)	(27.6)	(25.3)	(29.3)	(28.8)	(27.2)
plus												
BEGINNING INVENTORY	66.4[4]	76.8	91.3	98.0	98.1	91.5	78.0	56.6	29.0	3.7	-0-	-0-
equals												
ENDING INVENTORY	76.8	91.3	98.0	98.1	91.5	78.0	56.6	29.0	37.0	-0-	-0-	-0-
RELATIVE INVENTORY (yrs)[5]	2.7	4.2	3.7	3.3	2.8	2.3	1.8	1.2	0.6	0.1	-0-	-0-

[1] Nuexco Report 145, Table 7.
[2] Nuexco Report 144, Table 1.
[3] Nuexco Report 142, Table 3.
[4] George F. Combs, Jr.: "The US Uranium Market—1978-1979" USDOE; Grand Junction, Colorado; October, 1979.
[5] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Comex warehouses. Prices were low, due in part to the perception of ample supply based on the large inventories. The LME average price for copper wirebar during 1978 was about US$0.62 per pound, estimated to be below the full cost of production of many mines.

The price of copper began to recover in late 1978 and early 1979. Severe production and shipping problems in Zambia and Zaire resulted in a draw down of inventories. The potential for strikes in the US was viewed by users and speculators as a reason to maintain relatively high inventories. The perception of a possible shortage thus caused the price to be bid up. The average LME price in 1979 was about US$0.90 per pound, and reached around US$1.40 per pound in early 1980.

World (outside communist areas) copper inventory levels had been above 2.2 million tons in early 1978, and decreased to 1.2 million tons by the end of 1979. For comparison, world (outside communist areas) copper consumption in 1979 was about 8.25 million tons, and production was 7.7 million tons. Thus world copper inventories at the end of 1979 were drawn down to about an eight week supply. This was perceived as a relatively tight inventory situation given the real and potential supply shortfalls at the time, and was a principal cause of the rising price of copper during 1979 and early 1980.

Effect of Inventory

The inventory in any commodity is the surge tank between production and consumption. The relative inventory level often serves as a bellwether of commodity price movements. In the copper market, an inventory of 1.2 million tons was viewed as insufficient at a time when buyers perceived the existence of, or possibility of, production problems in some areas of the world. (At other times, such an inventory level has been viewed as sufficient.)

Returning to the uranium market and the comparison between the current situation and the market in the early 1970's, the question of inventory levels should be addressed. Inventories in the copper market are relatively thin in comparison to the uranium market. World copper inventories are on the order of a few months' consumption at most, while world (outside communist areas) uranium inventories, as well as US inventories, are currently at least three times annual consumption (see Table 3 and Table 4). One result of the difference is that the copper market can be expected to be relatively volatile with changing market perceptions quickly leading to price movements. The economic cycle for uranium appears to be much longer.

US commercial uranium inventories as of the end of 1972 were small, compared to the current situation. In 1973, the USAEC estimated[2] that US commercial inventories as of the end of 1972 amounted to about 25 million pounds U_3O_8. Predicted forward annual requirements at that time were about 16 million pounds in 1973, and 23 million pounds in 1974. The dampening effect of inventory was therefore much lower than today, and perceived shortfalls were quickly translated into market action. Much buying activity commenced in 1973, and prices were continuously bid up through early 1976, when they reached a broad plateau. Today, US commercial inventories of natural uranium are expected to be in excess of 90 million pounds U_3O_8 by the end of 1980, much higher than predicted annual US consumption over the next few years. This high inventory will probably tend to act as a buffer to changes in market perceptions brought on by the predicted shortfall in US production in the mid-1980's. There will be other factors to consider as well, such as non-US production. However, the most important factor is likely to be the effect of inventories. The influence of the industry's inventory level on the market will in turn depend on the collective judgment of the individual utilities on how much inventory is really needed.

Unique Aspects of Uranium Inventory

In the US, the nuclear power industry could operate on inventory alone for at least three years. This of course greatly contributes to the perception of a more-than-adequate supply of uranium. Some of this utility inventory has been recycled into the market, contributing to downward pressure on prices. The mere fact that some inventory has been sold into the market tends to further aggravate an already bearish situation because of the potential for additional inventory sales; i.e. a domino effect. US utility inventories are unevenly distributed, and several US utilities hold more than five million pounds each. The decision of only one of these utilities to liquidate would put great downward pressure on what is now a thin market.

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[2] *Ibid.*

TOPICAL ESSAY

Pricing considerations which apply to inventory selling are different than those associated with classical economic pressures. Decisions to build or liquidate inventories are largely, though not wholly, policy decisions dependent in part on perceptions related to security of supply, future price outlook, utility cash requirements, etc. Much depends upon financial treatment and tangibles. One important intangible is the ability of the utility to recover its cost of carrying the uranium inventory. A federal agency, the Federal Energy Regulatory Commission (FERC) is now developing guidelines which will influence whether and to what extent US utilities are compensated for inventory carrying charges. Thus utility inventory decisions are likely to be based upon a broad spectrum of considerations.

With inventories in such a pivotal position, utility decisions on this issue can literally dominate the market. If wholesale decisions are made to reduce inventories (or, in a thin market, if only a few such decisions are made), spot market prices are likely to be depressed well below what might be expected by analyzing only production and consumption. If, on the other hand, utilities view inventories as being beneficial, the apparent shortfall in US production over the next few years might be perceived as to bring about a real resurgence in interest in long term supply contracts. Utility patterns and policies regarding inventories are the all-important difference in the current market vis-a-vis the early 1970's. These patterns and policies must be carefully monitored if the behavior of the market is to be accurately assessed.

COMMENTARY

THE EMBARGO ISSUE

US Senator Peter Domenici (Republican, New Mexico) was successful in attaching an amendment to the Senate's version of the 1981 US Department of Energy (USDOE) appropriations bill. The amendment had the potential to limit the use by US utilities of non-US origin uranium. However, the proposed amendment was deleted by a House-Senate conference committee, and the final bill forwarded to the President did not include any language related to an embargo.

The defeated amendment was somewhat peculiar. The first section prohibited enrichment of feed for use in the US reactors where the foreign feed component exceeded 10 percent, but excluded from this prohibition all enrichment contracts signed prior to October 1, 1980. Since US reactors either operating, under construction or on order are already covered by enrichment contracts and since the bill was an appropriations bill covering only one fiscal year, this section was essentially meaningless.

The second section of the proposed amendment, however, directed USDOE to conduct a rulemaking to establish restrictions on the domestic use of foreign origin uranium to the extent necessary to protect the viability of the US uranium production industry. It was this latter provision that brought forth the strongest reactions from US utilities, the US Department of State and the US Department of Energy.

US utilities generally went on record as opposing any actions that would reduce uranium procurement flexibility. The Department of State had to contend with objections from Canada and Australia, which feared the cut-off of potential markets. USDOE felt that a rulemaking was premature and reported that the balance of uranium imports and exports is under continuing study in the Department, and its view was that imports of non-US uranium were clearly not a factor in the recent price weakness reflected in the market. Thus a reimposition of the embargo would not likely have a significant effect on spot prices in the US.

The popular press has picked up on the issue of potential US uranium import dependence. The possibility of such dependence has become more apparent in recent months as weakening prices have led to many production cutbacks in the US, with more expected. The resultant shortfall in production will likely be compensated to a significant extent by imports.

Thus if some import dependence is expected, the comparison between imported oil and imported uranium naturally arises. One reason often given in favor of a uranium import embargo is the prevention of problems in the uranium market similar to the current problems in oil. There are, however, fundamental differences between uranium import dependence and oil import depedence, which are often overlooked in drawing these comparisons.

Production and Consumption: The US does not have the capability to produce all the oil it currently consumes. Oil usage is currently around 17-18 million barrels per day. US production is only about 9 million barrels per day. On the other hand, the US has the current capability to produce over 40 million pounds U_3O_8 annually and production could be expanded to 50 million pounds within a few years if required and if market conditions permitted. Consumption however is currently less than 25 million pounds annually. Thus the situations vis-à-vis oil and uranium are opposites with respect to production versus consumption.

Fuel Characteristics: When oil supplies are cut off the effects are immediate. The physical capability to inventory oil is limited. Uranium is substantially different. Large inventories, equivalent, in aggregate, to at least three years forward consumption are now on hand. There is no limit, other than financial, to the amount of U_3O_8 that can be inventoried. Thus even if substantial foreign deliveries were cut off, existing inventories could absorb any shortfall for years. The existing US government strategic stockpile is a further buffer. Finally, the characteristics of nuclear power plants allow their operation to be extended, adding still a further buffer. Thus there would be more than adequate time to increase US production to the level necessary to make up for any foreign supply that might be cut off.

Thus attempts to draw parallels between the existing situation in the US with respect to dependence on foreign oil and the degree of prospective dependence on foreign uranium tend to ignore important basic differences between the two commodities and can lead to inaccurate conclusions.

RAW MATERIALS

URANIUM RECOVERY BY HEAP LEACHING

Generally, the uranium production industry has been processing ores of lower average grade during the last few years. This is particularly true in the United States where the average grade of conventional milling operations has decreased from 0.20% U_3O_8 in 1970 to 0.11% in 1979. The average grade of ore processed is the most important cost consideration involved in producing a pound of uranium oxide. Thus, as the average grade of ore decreases, alternative recovery technology is becoming important in maintaining or improving project economics.

This does not necessarily apply to every project. The economics of a large-tonnage mine and mill operation may be proportional to the volume of material processed; average grade of the material becomes a secondary consideration to volume. The Rossing operation in Namibia is an example. The average grade of mill feed at Rossing is between 0.035 and 0.045 percent U_3O_8; mill volume is about 40,000 tonnes per day.

Uranium produced as a by-product or co-product of another mineral in the ore, will normally not be amenable to alternative recovery technology because most of the recovery costs are assigned to the other mineral. Two examples of this are represented by the recovery of uranium as a by-product to gold recovery from the quartz-pebble conglomerates in the Witwatersrand region of South Africa, and the recovery of uranium as a co-product to vanadium in certain deposits in the Colorado Plateau area of Colorado and Utah.

The need to improve the economics of recovery are perhaps more critical in the US uranium industry than other producing areas. Nuexco has estimated the total cost of about 50 percent of current production in the US—presently at an annual rate of 34.5 million pounds U_3O_8—probably exceed $30.00 per pound U_3O_8. In today's market, such costs leave little or no profit for certain producers. A reduction in future capital and/or operating costs may determine whether or not such producers remain in business.

Opportunities to improve cost related processing methods are somewhat limited for conventional operations. Conventional uranium ore processing methods have remained essentially unchanged since the first plants were built in the early 1950's. Today's operators are utilizing old recovery methods in a new environment of inflated costs and decreasing market potential.

The principle alternatives for reducing production costs are:

1. Raise the cut-off grade of mined ore, and thereby lower unit cost, but at the expense of decreasing mine life by making lower grade ore unavailable,
2. Improve overall mill recovery efficiency. In all probability, prudent operators have already implemented adjustments in both areas, and projects are already at or above, design efficiency.

Attempts to implement these changes have been less than satisfactory for certain operators. Average ore grades have continued to decline. More tons of lower grade ore are being mined and processed to maintain annual production levels. Although average mill recovery has increased from about 87 percent in 1960 to about 94 percent today, the overall contribution to a reduction in costs has not net been significant.

Thus any significant reduction in production costs will have to come through the implementation of new and unconventional recovery techniques. One of the more promising of the techniques is solution mining; the recovery of uranium through dissolution, by the introduction of a suitable leaching solution into the mineral-bearing material.

Solution Mining

Solution mining can occur through the application of several different techniques. The leaching of ore in place—in situ leaching—offers the greatest potential to reduce production costs through a reduction in the number of cost-related operating steps, as compared to conventional mining and milling. However, the application of solution mining to existing conventional operations, is, for all practical purposes, limited to the recovery of uranium from ore by the process of heap leaching—the saturation of ore piles, usually low grade stockpiles or dumps, with a leaching solution to remove at least a part of the uranium contained in the material. The process is a means to recover a portion of sunk costs in low grade material removed from the mine in the normal process of mining higher grade ore, thereby improving the overall economics of the project.

Heap leaching does not require large capital expenditures or high on-going operating costs, as compared to conventional milling, since a number of steps are eliminated. The important areas of cost saving include the elimination of fine grinding, agitation, and liquid/solid separation. Heap leaching costs are limited to mining the material, crushing to optimum size for leaching (most sandstone ore does not require crushing), transportation to the leach site and preparation of the leach site. Final solution purification and precipitation facilities, if required, can be constructed on the site at minimal expense, or the high grade liquor can be transported directly to an existing mill facility.

History of Heap Leaching

Heap leaching is an old and commonly used metallurgical process. It is used to extract metal values from material which does not contain enough values to justify the capital expenditure necessary for the more conventional extraction process designed for higher grade ores. The art of heap leaching began in the 16th century, probably utilizing oxidized copper ores, and possibly gold and silver ores as well. Process technology has advanced rapidly in recent years with the development of hydrometallurgy, and today, heap leaching of many different ores, including uranium, is commonplace. In fact, some five billion tonnes of stockpiled low grade ore and waste dump material is, or is programmed to be, subjected to some form of heap leaching. Copper dumps, primarily in the western US, make up the largest percentage of material being leached.

Heap leaching of uranium ores on a large scale is relatively new, dating back to the early-1960's. The first leaching was done on low grade ore in the Gas Hills district of Wyoming. About 500,000 tonnes of material, containing 0.05 percent U_3O_8, was subjected to heap leaching over a period of several years. A total of approximately 400,000 pounds U_3O_8 was recovered. The success of the initial heap leach project stimulated other projects in the Gas Hills, the Shirley Basin district in Wyoming and the Maybell district in Colorado. In each case, the purpose of the project was accomplished, namely to recover U_3O_8 from material which otherwise could not have been economically processed by conventional methods.

Technology of Heap Leaching

The heap leaching process begins with the introduction of a leaching solution, usually consisting of dilute sulfuric acid, to the surface of a prepared stockpile of low grade material. The acidic solution is allowed to percolate to the bottom of the pile, where it is collected, and stripped of the contained uranium by conventional extraction or ion exchange methods. However, the actual design and operation of a heap leach facility is necessarily preceded by controlled laboratory testing from which a full scale project evolves.

Laboratory tests are conducted on specially selected and prepared samples taken from the stockpile of material being considered for leaching. Such tests are required to determine acid consumption, the rate of solution flow through the ore, the percentage of U_3O_8 recovery and preliminary design parameters. An estimate of project economics can be determined from laboratory tests.

Favorable laboratory tests are normally followed by a pilot test program at the mine site, in which larger volumes of ore are to be leached under design conditions. The pilot tests yield data that are designed into the full scale operation. Specifically, the data refer to the design and construction of the leach pad, the overall tonnage to be stacked on the pad, appropriate particle size and stacking technique to minimize compaction, the flow-rate of the leach solution through the material, the optimum leaching solution and the percentage of uranium recovered. The pilot test results allow for a final assessment of project economics.

The design of a leach pad and the tonnage to be stacked for leaching are influenced by the total volume of material to be leached and/or the availability of a favorable leach site. An ore pile that must be moved at the conclusion of a leach cycle may be limited in size to about 20,000 tonnes of ore. Once the spent ore is removed, a new ore supply can be stacked on the pad and the leaching process resumed. At the conclusion of leaching, the pad site is restored to approved environmental standards. Larger heap leach sites may contain up to 500,000 tonnes ore, all of which remains on site after leaching is concluded.

Design and construction of a heap leach pad is critical to a successful leach operation. The pad site is carefully prepared by grading the surface into evenly spaced troughs across the width. The pad is then made impervious to water flow by means of a tightly packed layer of clay, although polyethelene sheeting is commonly used on small pads. Perforated pipe, usually four to six inches in diameter, is then placed in each trough to collect the leaching solution as it seeps through the ore. A layer of pea gravel is spread over the pad to insulate the perforated pipe from the ore and to facilitate the free flow of solution into the collection system.

The mechanics of loading the pad may vary according to the particle size and compaction qualities of the ore, however, due to the volume of material to be stacked, the most common method is to use dump trucks with a 10 to 15 ton capacity. The oads are dumped on pad and flattened with a crawler tractor to minimize compaction. The procedure is repeated until the desired thickness of ore is achieved.

Thickness of the heap is determined during the pilot testing. Thickness can vary from about one meter up to eight or ten meters for the larger operations. However, experience has demonstrated that a thickness of five to seven meters is optimum for sandstone ores.

Final heap preparation includes the construction of low berms at the top surface of the heap to separate it into several holding reservoirs for the solution. The purpose of the reservoirs is for fine tune control of the leaching solutions, as well as to minimize damage from wave action or washout. At this point the site is ready for leaching.

The leaching solution is prepared in special holding tanks to an acid concentration determined in the pilot operation. It is pumped or sprayed on the reservoir areas and the leaching cycle begins.

The heap is prepared to facilitate complete saturation of the heap by the leaching solution. Dissolution of the uranium begins with saturation and continues as long as the solution is in contact with the uranium. Eventually, the rate of dissolution reaches a predetermined cutoff level, and the leaching process is terminated.

The uranium content of the solution collected from the bottom of the heap is usually maintained at a fairly constant level. This is controlled by the makeup of the solution and the contact time. If proper conditions are maintained, 60 to 80 percent of the uranium in the ore will be recovered, depending upon the percentage of material actually saturated by the leach solution. The usual desired rate of recovery is 1.0 to 2.0 grams of U_3O_8 per liter of solution. Uranium bearing solution is sent to a final recovery facility. If the uranium content drops below 1.0 grams per liter, the solution is usually recirculated.

The use of an acid leach solution has been emphasized in this article because most experience with heap leaching of uranium has involved sandstone ores in the western US. The leached ores generally contain the secondary uranium minerals carnotite and antunite, both of which are readily dissolved by acid in the absence of an oxidant. However, an oxidant may be required to keep the dissolved uranium in solution throughout the leach cycle. In that case, a chlorate is added to the leach solution at the make-up point.

Primary uranium minerals, mainly uraninite or pitchblende, can also be recovered by heap leaching. They require an oxidizing agent such as hydrogen peroxide, chlorate or oxygen to bring about dissolution. An acid solution is faster acting than the oxidants, however it is also non-discriminating and most minerals contained in the ore-bearing material are affected by the acid. This causes higher acid consumption and extra clean-up steps in the final stages of processing. Both effects add to project costs.

Conclusion

Historically, the use of heap leaching has been dependent on favorable economics and the mineralogical characteristics of the material to be leached. As is currently the case for all aspects of uranium mining and processing, operational and economic advantages once available by heap leaching have been gjeopardized by recently enacted environmental regulations. Nevertheless, when considered as an alternative to conventional recovery methods, heap leaching can still be a viable method for the recovery of uranium from low grade ores.

STATISTICAL DATA

EXCHANGE VALUE—$28.50/lb U_3O_8
Determined as of September 30, 1980

Definition

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of September 30, 1980

$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
30.60	2.0	15	4

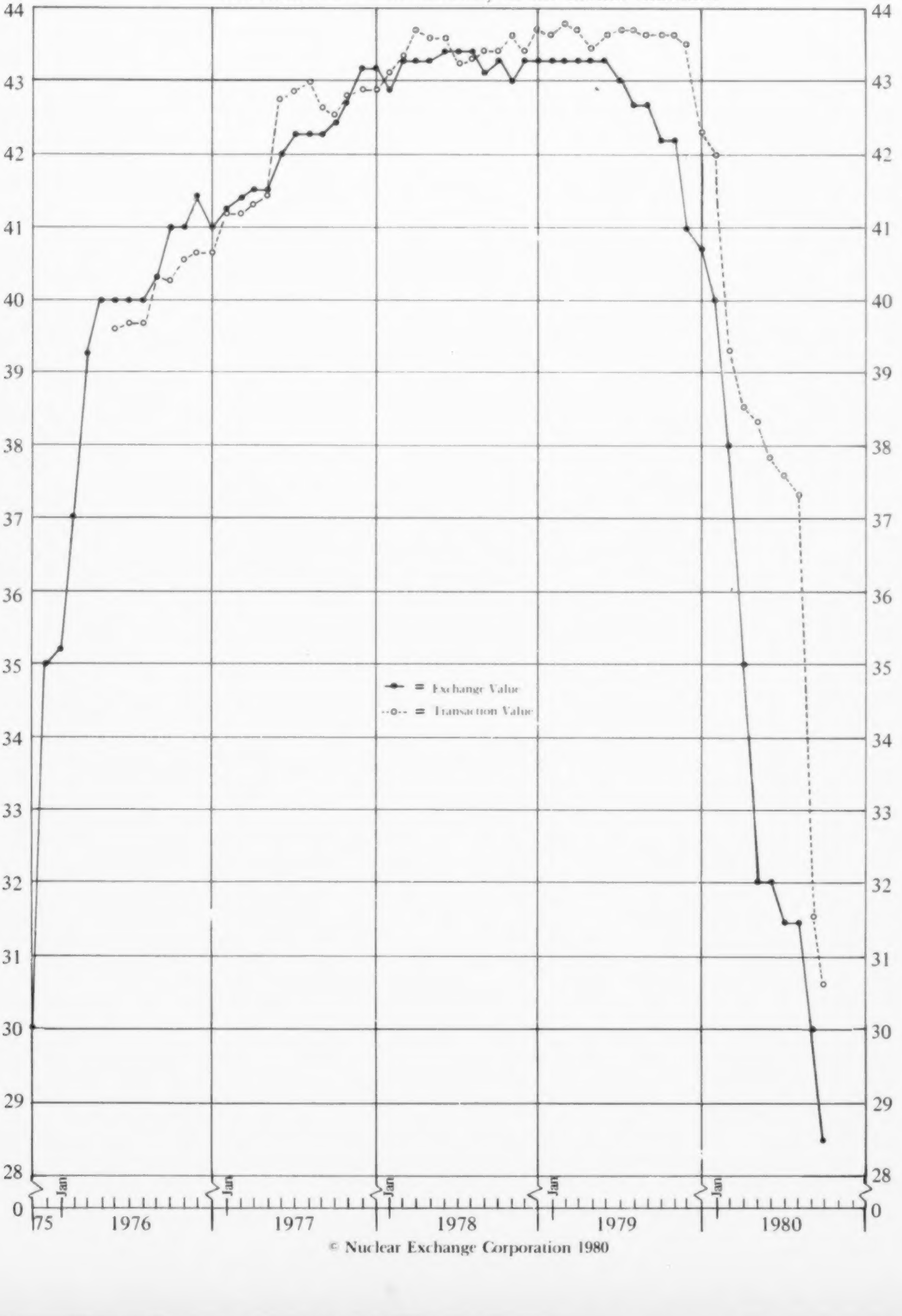
Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES SINCE NOVEMBER 1975

Determined as of the last day of the month indicated



HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated

(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50			

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated

(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60			

Note: See Nuexco Report 135 for a discussion of the definition of Transaction Value.

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	28.50	62.83	74.09
France (franc)	119.00	262.35	309.37
FRG (mark)	51.30	113.09	133.36
Japan (yen)	6,128	13,509	15,931
Switzerland (franc)	46.93	103.46	122.00
UK (pound)	11.87	26.16	30.85
Australia (dollar)	24.35	53.69	63.32
Canada (dollar)	33.19	73.16	86.28
Niger, Gabon (CFA)	5,950	13,117	15,468
South Africa (rand)	21.44	47.28	55.75

*Calculated using currency exchange rates published in the Wall Street Journal on the last Friday of the month.

LOAN USE CHARGE RATE—7.0%/year

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Nuexco Reference Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as percent of Current E.V.	Seller Group	Buyer Group	Remarks
1206	80	101 – 300	98	US	Europe	
1209	81-85	601 – 1000	–	US	US	Price related to market.
1210	80	51 – 100	98	US	Europe	

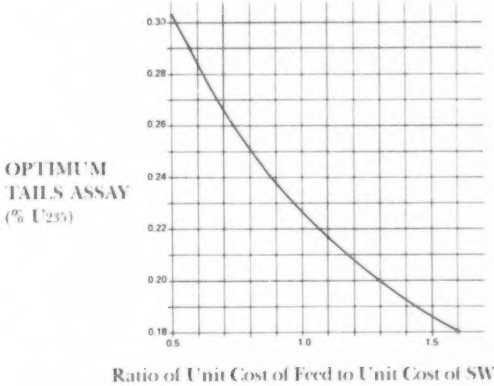
*Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

STATISTICAL DATA

OPTIMUM TAILS ASSAY

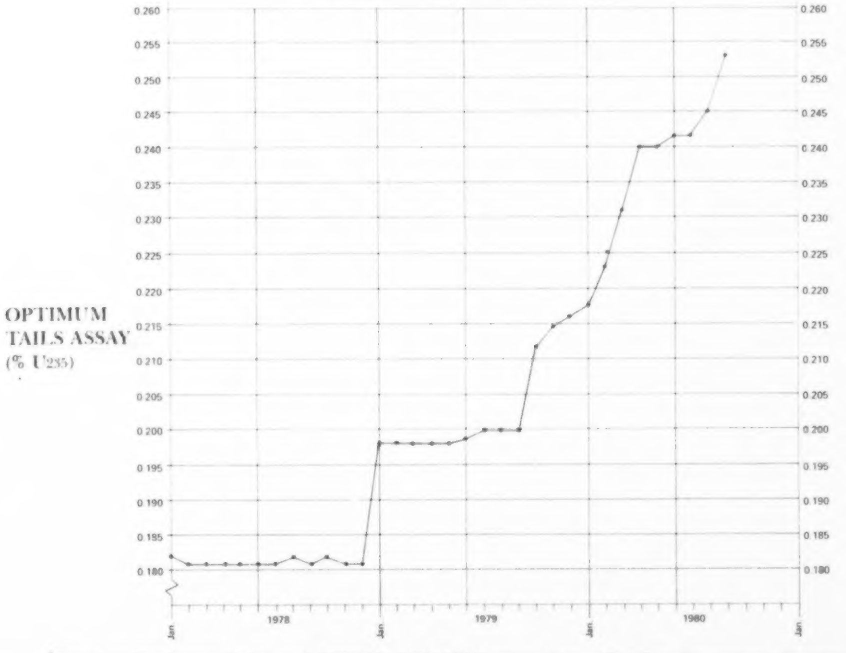
The optimum tails assay is the tails composition at which the cost of enriched uranium is lowest for given costs of separative work (SWU) and natural uranium feed. It depends only on the ratio of the cost of a kilogram of natural uranium in the form of UF_6 to the cost of a kilogram unit of separative work. The US Department of Energy (USDOE) Adjustable Fixed Commitment (AFC) enrichment contract holders have the option, within limits, to specify the transaction tails assay. The transaction tails assay for USDOE Requirements contracts is 0.2 percent U_{235}. For every one-hundredth of one percent increase in the transaction tails assay, uranium consumption increases about two percent.

TAILS ASSAY FOR MINIMUM COST OF PRODUCT*



*From Nuexco Report 138

HISTORICAL OPTIMUM TAILS ASSAY[1]



[1] Based on Exchange Value and USDOE AFC SWU price; interpolated to the nearest thousandth.

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 100)[1]	Consumer Price Index (1967 = 100)[2]	GNP Implicit Price Deflator (1972 = 100)[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]		
				Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)
Annual Avg. 1970 (5)	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971 (5)	114.1	121.3	96.02	4.12	4.15	3.97
Annual Avg. 1972 (5)	117.9	125.3	100.00	4.56	4.59	4.26
Annual Avg. 1973 (5)	125.9	133.1	105.80	4.84	4.98	4.51
Annual Avg. 1974 (5)	153.8	147.7	116.02	5.44	5.63	4.88
Annual Avg. 1975 (5)	171.5	161.2	127.15	6.13	6.24	5.39
Annual Avg. 1976 (5)	182.4	170.5	133.71	6.76	6.87	5.91
Annual Avg. 1977 (5)	195.1	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978 (5)	209.4	195.4	152.05	8.23	8.56	7.01
Annual Avg. 1979	236.5	217.4	165.46	9.27	9.50	7.59
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9	–	9.32	9.57	7.60
Aug 1979	240.6	221.1	–	9.38	9.70	7.65
Sep 1979	244.2	223.4	167.20	9.63	9.79	7.73
Oct 1979	249.0	225.4	–	9.67	9.87	7.82
Nov 1979	250.6	227.5	–	9.79	9.86	7.87
Dec 1979	253.1	229.9	170.58	9.80	9.92	7.91
Jan 1980	260.6	233.2	–	9.92	10.06	7.96
Feb 1980	265.9	236.4	–	9.93	10.01	7.99
Mar 1980	268.2	239.8	174.48	9.91	10.23	8.04
Apr 1980	270.7	242.5	–	10.00	10.30	8.12
May 1980	271.2	239.8	–	10.18	10.37	8.17
Jun 1980	273.0	247.6	178.93	10.13	10.69	8.24
Jul 1980	275.6P	247.8	–	10.18P	10.80P	8.35P
Aug 1980	277.3P	249.4	–	–	–	8.39P

P = Preliminary   R = Revised since last month

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, DC.; "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. Data for January 1977 through March 1980 are adjusted to the March 1978 benchmark. Data for April 1980 and beyond are adjusted to the most recent benchmark—March 1979.

(5) Data for 1970-1978, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Nuexco Report 139.

STATISTICAL DATA

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry—All Groups (Year 1968-69 = 100.0)[1]	**Weighted Average Minimum Weekly Wage Rates—Adult Males Australia Mining and Quarrying (A$)[2]**
Annual Avg. 1970(3)	101.4	59.88
Annual Avg. 1971(3)	101.5	65.95
Annual Avg. 1972(3)	105.6	71.26
Annual Avg. 1973(3)	124.4	78.96
Annual Avg. 1974(3)	141.9	108.07
Annual Avg. 1975(3)	150.4	132.55
Annual Avg. 1976(3)	168.4	160.93
Annual Avg. 1977(3)	192.0	179.03
Annual Avg. 1978(3)	215.4	190.04
Annual Avg. 1979	248.5	196.34
Apr 1979	274.0	192.46
May 1979	288.5	193.55R
Jun 1979	294.9	196.63R
Jul 1979	298.2	199.20R
Aug 1979	293.2	200.27R
Sep 1979	302.4	201.05R
Oct 1979	309.4	200.51R
Nov 1979	310.4	199.85R
Dec 1979	319.4	200.66R
Jan 1980	340.1	215.43R
Feb 1980	345.6	214.89R
Mar 1980	340.3	214.35R
Apr 1980	327.9	214.65R
May 1980	335.1P	214.24R
Jun 1980	338.4P	213.58P
Jul 1980	–	–

P = Preliminary   R = Revised since last month

(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

(2) Australian Bureau of Statistics, Canberra; "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest fourteen months shown are subject to revision.

(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Nuexco Report 138.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000)^{1,2} (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings (C$)^{3,4}		
		Metal Mining, including milling (SIC 050-059)	Primary Metal Industries, non-ferrous (SIC 296-298)	Chemicals and Chemical Products (SIC 370-379)
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Annual Avg. 1979	217.9	9.60	7.35	7.67
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3	9.37	7.34	7.73
Aug 1979	220.0	9.56	7.38	7.77
Sep 1979	223.4	9.75	7.50	7.81
Oct 1979	227.4	9.89	7.54	7.88
Nov 1979	228.1	9.97	7.61	7.91
Dec 1979	230.4	9.93	7.51	7.89
Jan 1980	239.0R	9.96	7.57	7.99
Feb 1980	240.8R	10.11	7.69	8.08
Mar 1980	239.5R	10.34	7.83	8.26
Apr 1980	241.1R	10.40P	7.94P	8.36P
May 1980	242.2R	10.49P	8.02P	8.44P
Jun 1980	243.3	—	—	—
Jul 1980	245.8P	—	—	—

P = Preliminary   R = Revised since last month

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 4.10 of Nuexco Report 138.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 4.11 of Nuexco Report 138.

REPUBLIC OF SOUTH AFRICA STATISTICS

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100, except where otherwise indicated)
Annual Avg. 1970 (3)	7.34	100.3 (4)
Annual Avg. 1971 (3)	7.88	106.4 (4)
Annual Avg. 1972 (3)	8.79	113.3 (4)
Annual Avg. 1973 (3)	10.51	124.1 (4)
Annual Avg. 1974 (3)	13.18	138.5 (4)
Annual Avg. 1975 (3)	16.71	157.2 (4)
Annual Avg. 1976 (3)	19.30	174.7 (4)
Annual Avg. 1977 (3)	23.87	194.4 (4)
Annual Avg. 1978 (3)	27.14	137.2
Annual Avg. 1979 (3)	30.18	155.3
Jun 1979	29.44	152.4
Jul 1979	–	157.9
Aug 1979	–	160.2
Sep 1979	30.71	162.1
Oct 1979	–	162.9
Nov 1979	–	163.4
Dec 1979	31.89	164.0
Jan 1980	–	165.4
Feb 1980	–	167.0
Mar 1980	33.65	168.0
Apr 1980	–	170.0
May 1980	–	171.9
Jun 1980	34.08	174.6
Jul 1980	–	–
Aug 1980	–	–

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(1) Chamber of Mines of South Africa, Johannesburg: "Analysis of Working Results," published quarterly.

(2) Republic of South Africa Department of Statistics, Pretoria: "Government Gazette: Consumer Price Index for Urban Areas."

(3) Historical data for 1970 through 1979 appear on page 4.9 of Nuexco Report 140.

(4) April 1970 = 100.00

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM SUPPLY

Nuexco Reference Number	Delivery Period* (Thousands of Pounds U_3O_8)			Remarks
	0 to 1 Year	1 to 2 Years	2 to 3 Years	
Available for Sale:				
1236			150	Long term
1284	250			
1286	150	150	150	Long term
1392	300			
1394	250			
1417	1000			UF_6
1475	1000			UF_6
1479	525			
1481	250			
1496	500			
1502	500			UF_6
1506		200	200	Long term
TOTALS	4725	350	500	
Available for Loan:				
1175	700			UF_6
1234	700			
1354	600			UF_6
1355	600			
1429	500			
1492	700			UF_6
TOTAL	3800			

***Measured from the date of this Report.**

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM DEMAND

Nuexco Reference Number	Delivery Period* (Thousands of Pounds U_3O_8)			Remarks
	0 to 1 Year	1 to 2 Years	2 to 3 Years	
Inquiries to Purchase:				
1321	900			
1408	150			
1459		200	200	Long term
1462			100	Long term
1470	25			
1488	120			
1489	200			
1497	500			
1501	150			
TOTALS	2045	200	300	
Inquiries to Borrow:				
1220	500			
1504	1000			UF_6
TOTAL	1500			

***Measured from the date of this Report.**

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the secondary market for UF_6 conversion services. The data presented in this section are in no way intended to be indicative of the entire market for the time period covered.

CONVERSION SUPPLY

Nuexco Reference Number	Thousands of Pounds U as UF_6				Remarks
	1980	1981	1982	1983	
P-1282	250	250			
P-1424	1000				
P-1450	1000				
P-1451	175				
TOTALS	2425	250			

CONVERSION DEMAND

Nuexco Reference Number	Thousands of Pounds U as UF_6				Remarks
	1980	1981	1982	1983	
P-1505	770				

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT 146

The **Exchange Value** declined this month to $28.50 per pound U_3O_8 from $30.00 last month. Sellers continued to aggressively compete for new business. Active spot and near term sellers include producers and both utility and non-utility inventory holders. Active spot and near term purchasers are mainly non-US utilities and US producers, although at least one US utility has recently decided to enter the near term market to take advantage of today's prices. Spot and near term inquiries to sell total about 4.7 million pounds U_3O_8, while inquiries to purchase in the same time frame amount to about two million pounds. Thus the market is becoming somewhat more balanced than it has been recently.

Three transactions closed this month, all involving US producers as sellers. The buyers in two of the transactions were European utilities. The third buyer was a US utility. The **Transaction Value** declined to $30.60 per pound U_3O_8 from $31.60 last month.

The US Department of Energy (USDOE) "Survey of United States Uranium Marketing Activity" was issued this month. Data on US production and prices contained in the USDOE survey are discussed in this month's Nuexco Report.

An amendment aimed at restricting use of non-US uranium in US reactors was removed from the 1981 appropriations bill for USDOE by a House-Senate conference committee. This action is addressed in the *Commentary* section of this Report, along with some general comments on the uranium embargo question.

Some additional details of the financial structure and sales commitments of Energy Resources of Australia (ERA) have become available and are outlined in this Report.

This month's *Topical Essay* compares the depressed uranium market of the early 1970's with today's market, and assesses whether a market recovery similiar to that of the mid-1970's is likely.

The *Raw Materials* section discusses the process of recovering uranium by heap leaching.

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